PROCEEDINGS

Sixty-Eighth Annual Convention

OF THE

American Railway Bridge & Building Association

1963

Proceedings of the

Sixty-Eighth Annual Convention

of the

American Railway
Bridge & Building
Association

Held at

CHICAGO, ILLINOIS

October 14-16, 1963

Published by the Association
Ruth Weggeberg, Secretary
220 So. Michigan Ave., Chicago 4

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Illinois Central, Chicago

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J. W. DeValle, Southern ..... Washington, D.C.

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Hands across the rails

THE nation's railroads do an outstanding job—in spite of the handicaps under which they operate. Over the years, management has shouldered enormous burdens in meeting crises and emergencies with better methods and equipment.

Contributing greatly to railroad progress and efficiency are the many railroad clubs, associations and societies, and the industry's suppliers who believe in offering more than product alone.

We of Oxweld Railroad Department are proud to count ourselves among the leaders of this latter group. Our product contributions—oxy-acetylene and electric welding equipment, ULOK Air Filters, industrial gases, and other equipment —are well known to railroaders. So are LINDE's service, research and development, and technical support. You can count on our service engineers to go out "on the track" with your specialists when you need them to demonstrate and explain new techniques, and to help tackle new problems.

Behind our men are three major laboratories devoted to research in areas that can, and have, improved railroad operations, plus 13 additional Union Carbide laboratories working on related projects.

All these services and resources are at your railroad's disposal—at no expense. Your problems are our problems. For specific answers, write Union Carbide Corporation, Linde Division, Oxweld Railroad Department, 270 Park Ave., New York, N.Y. 10017, or 230 North Michigan Ave., Chicago, Ill. 60601.

OXWELD RAILROAD DEPARTMENT

UNION CARBIDE

LINDE DIVISION

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PROCEEDINGS

The Event—The 68th Annual Convention of the Bridge and Building Association
The Date—October 14-16, 1963
The Place—McCormick Place, Chicago, Ill.

The 68th annual convention of the American Railway Bridge and Building Association was held on October 14-16, 1963, in McCormick Place, Chicago, Ill., with the Pick-Congress Hotel as the official convention headquarters. Total attendance was 277, including railroad members, associate members and guests. The convention was held, as usual, concurrent with, although separate from, the annual convention of the Roadmasters' and Maintenance of Way Association. Total attendance at both the B&B and Roadmasters' conventions was 785, including 629 railroad members, 64 associate members and 96 guests.

Concurrent with both conventions and also held in McCormick Place was the giant "American Railway Progress Exposition" which began on October 9 and continued through the 16th. One of the main attractions of the exposition was the exhibit staged by the Combined Railway Suppliers' Exhibit Association, which included the Association of Track and Structure Suppliers and the National Railway Appliances Association. Some 350 railway supply companies exhibited their wares inside and outside McCormick Place, about 130 of these being in the M/W field. In addition to the Bridge and Building and Roadmasters' conventions, approximately 25 other railroad associations and groups held their annual conventions or meetings during the eight-day period of the exposition. In all, nearly 40,000 railway officers were drawn to the exposition.

President J. M. Lowry presided over the separate sessions of the B&B Association.

These proceedings give excerpts from two major addresses delivered during the single joint session of the conventions, the full text of one of the special features of the B&B meetings and the reports of five special subjects committees. In addition, the proceedings include the directory of members, the constitution and by-laws and other pertinent current and historical information.

Some 350 railway supply companies exhibited their wares.

Joint Session

As usual in an exhibit year, only one joint session was held during the conventions. This was held on Monday morning, October 14, and, in addition to the B&B and Roadmasters' Associations, was attended by members and guests of the Communication and Signal Section, Association of American Railroads. The joint session was the opening meeting of the conventions and featured addresses by J. H. Lloyd, vice president operation, Missouri Pacific, and J. H. McKenzie, president, St. Louis Southwestern. Mr. Lloyd's address was entitled "Today is Tomorrow." Mr. McKenzie spoke on Japan's new high-speed Tokaido Line and introduced a color motion picture taken along the line. His talk was entitled "What You Can Do with the Know-How If You Have the Yen."

When this joint session was adjourned those attending were invited to join with the members of all the other associations and groups holding meetings on Monday in the Arie Crown Theater to hear an address by a Defense Department official. The speaker was Assistant Secretary of the Navy Kenneth E. BeLieu, substituting for Secretary of the Navy Fred Korth who was unable to attend. Mr. BeLieu spoke principally on defense matters generally and the naval establishment in particular.

B&B Separate Sessions

Separate sessions of the Bridge and Building Association were held on Monday afternoon and Tuesday and Wednesday mornings. They were presided over by President J. M. Lowry. During these sessions the following committee reports were presented:

Construction Standards and Maintenance of Piggyback and Auto-Handling Facilities

Concrete Restoration Techniques in Current Use on Railroad Structures

Improved Bridge and Building Tools—Where Are We?—What Next?

Installation and Maintenance of Prefabricated or Precast Bridge Structures

Rail Anchorage on Bridge Decks

The Monday afternoon separate session featured a color motion picture on the construction of a bridge on the Southern Pacific across the Colorado river at Kingsland, Texas. The film was introduced by J. F. Hoss, supervisor of structures, Southern Pacific, Texas and Louisiana Lines.

The Tuesday morning session featured a color motion picture entitled "A Leg To Stand On." This film showed new techniques developed by International Underwater Contractors, Inc., College Point, N. Y., for making substructure repairs under water as observed by closed-circuit television. The film was presented by Andre Galerne, president of IUC, and Rene A. Fichter, president of Bondarc Corp., Douglaston, N. Y., sales representative for IUC to railroads in the United States.

The final session of the convention on Wednesday morning featured a symposium on "Remedial Measures to Restore Damaged Bridges." Members of the panel were E. A. Johnson, engineer of bridges, Illinois Central, and J. C. Nichols, bridge engineer, Louisville & Nashville. Both talks were illustrated with slides.

Remarks by President Lowry

It is gratifying to see so many of our members here. You guests are always welcome and we hope many of you will stay for the entire convention. I want to extend a special welcome to the ladies to attend any of our sessions in which they might have an interest.

You are all aware of the changes which have been made in our convention this year in order to cooperate with other railroad and supply organizations to make this the greatest convention ever. These changes have made necessary considerable work by your Executive committee above and beyond that of an ordinary year—changes in hotel arrangements, meeting rooms, coordinating meetings and other activities with other participating groups, to mention a few.

It is through changes that we grow, and change is sometimes painful. It is much easier for us to stay in a rut doing our jobs the same old way than to prod ourselves into thinking of new and better ways of accomplishing our work. But we *must* change. In the 68-year history of our association there have been many changes and improvements. I dare say, however, that we will see more changes in ways of doing B&B work in the next 15 years than all of the past 68.

Our management is depending on us to improve. We must accept the challenge and jolt our minds into thinking of different and better ways of doing the job.

Your B&B Association can help you here. By exchanging ideas, individually, as a group, and from the convention floor, we can help each other. This convention is the only opportunity many of us have to exchange ideas among so many with common interests. Let's take full advantage of it.

I should like to compliment the fine group of officers composing your Executive committee. They have worked tirelessly and with enthusiasm to a man to make our share of this great exposition a success. Committee chairmen, vice chairmen and all of you committee members came through with some very good reports which will, I'm sure, be interesting to all and arouse considerable discussion.

One of the highlights of our convention for many years has been the fine banquet with entertainment and dance tendered the

J. F. Hoss, SP, introduced a motion picture showing the construction of a bridge.

After a motion picture on underwater repairs Andre Galerne, president, IUC (standing), and R. A. Fichter, railroad sales representative, answered questions.

Roadmasters' and our association by the Association of Track and Structure Suppliers. This has come to be as much a part of our convention as our committee reports, and I am happy to say that we are again this year to enjoy this event. It took a very special effort on the part of this fine organization to make the banquet a reality this year. We owe them a special vote of thanks for this extra effort.

New Honorary Member Elected

At the business session of the B&B meeting, held on Wednesday morning, L. C. Winkelhaus, a member of the association since 1934, a life member since 1955 and Treasurer since 1948, was elected an Honorary member in accordance with the procedures outlined in the Constitution. Mr. Winkelhaus has resigned as Treasurer of the association due to ill health.

The following were elected officers of the association for 1963-64:

President—E. R. Schlaf, superintendent of fire prevention, Illinois Central, Chicago, who was promoted from first vice president; first vice president—R. C. Baker, assistant chief engineer, Chicago & Eastern Illinois, Chicago Heights, Ill., who was advanced from third vice president; second vice president—Shirley White, general bridge and building supervisor, Southern Pacific, San Francisco, Calif., who was a director of the association; third vice president—H. M. Wilson, supervisor of structures, Pennsylvania, Chicago, also a director; treasurer—E. F. Snyder, assistant to chief engineer, Illinois Central, Chicago. Mrs. Ruth Weggeberg was re-elected secretary of the association.

New directors of the association elected for three-year terms are: J. A. Goforth, maintenance engineer, Clinchfield, Erwin, Tenn., and E. R. Simmons, supervisor of track and structures, St. Louis Southwestern, Pine Bluff, Ark.

New Committee Subjects

The new subjects selected for study by the association's special committees are:

1. Modern Heating, Insulating and ventilating Methods for Railway Buildings

2. Study of Most Economical Method of Renewing Bents Without Disturbance to and from Traffic

3. Installation and Maintenance of Tunnel Lining and Increasing Clearances in Tunnels

4. Latest Developments in Fire Prevention Methods and Material for Bridges and Buildings and Timber-Lined Tunnels

5. Inspection and Maintenance of Timber Trestles for Increased Wheel Loads

Each committee will report its findings and conclusions at the 1964 convention, to be held on September 14-16 at the Conrad Hilton Hotel, Chicago.

TREASURER'S REPORT

SEPTEMBER 1, 1962 TO AUGUST 31, 1963

Cash Balance—September 1, 1962			$ 118.42
RECEIPTS:			
Dues—1965	$ 5.00		
Dues—1964	674.00		
Dues—1963	1,894.80		
Dues—Prior	187.00	$2,760.80	
Advertising:			
1962 Proceedings		1,230.26	3,991.06
Total Receipts			$4,109.48
DISBURSEMENTS:			
Salaries (Secretary and Assistant)		$2,213.90	
Social Security		66.66	
Stationery and Printing		324.23	
Postage		300.66	
Office Rent, Telephone, Electricity		295.07	
Convention Expenses—1962		94.64	
Office Supplies		116.16	
Addressograph Plates		11.92	
Miscellaneous		39.16	3,462.40
Balance—August 31, 1963			$ 647.08

Cash on hand First National Bank of Chicago, August 31, 1963 ..... $ 647.08

September 16, 1963

APPROVED:

H. D. Curie
E. F. Snyder
G. W. Benson

L. C. WINKELHAUS, *Treasurer*

REPORT OF AUDITING COMMITTEE

TO MEMBERS OF THE
AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION:

Gentlemen:

The undersigned have examined the books of the Secretary and report of the Treasurer for the period from September 1, 1962, to August 31, 1963, inclusive, and have found them to be correct as of the latter date.

Respectfully submitted,

H. D. Curie, *Chairman*
E. F. Snyder
G. W. Benson

September 16, 1963

SECRETARY'S REPORT

ANNUAL REPORT OF MEMBERSHIP FOR PERIOD SEPTEMBER 10, 1962 TO OCTOBER 10, 1963

ACTIVE MEMBERSHIP:			
Total Active Members, September 10, 1962		700	
New Active Members since September 10, 1962		50	
Reinstated—Paid back dues		2	
		752	
LESS—Members reported deceased	5		
Resigned account retirement, etc.	28		
Transferred to Life Membership	12		
Transferred to Associate Membership	3		
Dropped for non-payment of dues	48	96	
TOTAL ACTIVE MEMBERS—OCTOBER 10, 1963			656
ASSOCIATE MEMBERS:			
Total Associate Members, September 10, 1962		129	
New Associate Members since September 10, 1962		4	
Transferred from Active to Associate Membership		3	
		136	
LESS—Members reported deceased	2		
Resigned account retirement, etc.	7		
Dropped for non-payment of dues	13	22	
TOTAL ASSOCIATE MEMBERS—OCTOBER 10, 1963			114
LIFE MEMBERS:			
Total Life Members, September 10, 1962		107	
Transferred to Life from Active Membership		12	
		119	
LESS—Reported deceased		6	
TOTAL LIFE MEMBERS—OCTOBER 10, 1963			113
HONORARY MEMBERS:			
Total Honorary Members, September 10, 1962		6	
LESS—Honorary Members reported deceased		2	
TOTAL HONORARY MEMBERS—OCTOBER 10, 1963			4
TOTAL MEMBERSHIP—ALL CLASSES—OCTOBER 10, 1963			887

October 11, 1963—rsw

REPORT OF NECROLOGY COMMITTEE

(1962-1963)

To the President and Members of

AMERICAN RAILWAY BRIDGE & BUILDING ASSOCIATION

We regret to advise that we have learned of the loss of fifteen (15) members through death during the year. It is possible that other members have passed away during the year of whom we have no information. If you know of any, we would like to have their names to include in the list to be printed in the Annual Proceedings. The following have been reported since our last Annual Meeting in September, 1962:

NAME	TITLE—RAILROAD	DATE JOINED	DATE DIED
Active Members:			
G. W. Brown	Supvr. Auto. & Wk. Equip. Southern Pacific Houston, Tex.	1955	March 18, 1963
K. R. Brown	B. & B. Supvr. Chicago & Eastern Illinois Salem, Ill.	1956	September, 1962

NAME	TITLE—RAILROAD	DATE JOINED	DATE DIED
Active Members:			
J. R. Houlgrave, Jr.	Draftsman Computer Southern Pacific Houston, Tex.	1963	August 15, 1963
J. A. Rose	B. & B. Master Canadian Pacific Montreal, Que.	1958	May 28, 1962
W. B. Starnes	Bridge Inspector Missouri Pacific Kingsville, Texas	1959	1962
Associate Members:			
A. J. Filkins	President Filkins & Son Co. Palatine, Ill.	1937	March 11, 1963
R. L. Fletcher	Structural Engineer Timber Engineering Co. Washington, D. C.	1947	November 1, 1962
Life Members:			
A. D. Gillis (Ret.)	B. & B. Supvr. New York, New Haven & Hartford Providence, R. I.	1923	1962
C. R. Harding (Ret.)	President The Pullman Company Easton, Md.	1924	March 4, 1963
J. R. Hartwell (Ret.)	Supvr. B. & B. Chicago & North Western Pierre, S. D.	1918	1963
M. Johnson (Ret.)	Prin. Asst. Engr. Illinois Central Chicago, Ill. (President B. & B. Assn. 1928-29)	1915	1962
C. A. Landstrom (Ret.)	Supvr. B. & B. Chicago, Burlington & Quincy Burlington, Iowa	1928	August 24, 1960
H. A. Wistrich (Ret.)	Chief Engineer Lehigh Valley Bethlehem, Pa.	1938	1962
Honorary Members:			
A. E. Bechtelheimer (Ret.)	Bridge Engineer Chicago & North Western Winnetka, Ill. (President B. & B. Assn. 1939-40)	1920	November 20, 1962
G. S. Crites (Ret.)	Division Engineer Baltimore & Ohio Baltimore, Md. (President B. & B. Assn. 1942-43)	1912	June 23, 1963

We deeply regret the passing of these, our fellow members.

May we stand a moment in silence to honor these departed members.

Respectfully submitted,
H. A. Matthews, *Chairman*

October 10, 1963—rsw

REPORT OF RESOLUTIONS COMMITTEE

The 68th year of the American Railway Bridge & Building Association is nearing the end of a very successful convention and a large registration.

Our principal speakers were outstanding and therefore it is fitting that we recognize the special efforts of all who contributed so much to make this a memorable year.

To this, we propose the following resolutions:

BE IT RESOLVED by the American Railway Bridge & Building Association in convention assembled that the thanks of the association be extended first to Rev. R. D. Gray, Pastor of the Calvary Memorial Church, Oak Park, Ill., who invoked the blessing and guidance on the activities of the combined associations and guests.

BE IT FURTHER RESOLVED, that the thanks of the association be extended to the Executive officers who honored us with their inspiring remarks and wise counsel, especially

Mr. J. H. Lloyd, Vice President Operations, Missouri Pacific Railroad and Mr. J. H. McKenzie, President, St. Louis Southwestern Railroad.

BE IT FURTHER RESOLVED, that the thanks of the association be extended to the Honorable Kenneth E. Belieu, Assistant Secretary in Charge of Logistics, U. S. Navy, for his pertinent and challenging remarks concerning the mutual needs for the defenses of our country.

BE IT FURTHER RESOLVED, that the thanks of the association be extended to Mr. J. F. Hoss, Supervisor of Structures, Southern Pacific Company—Texas and Louisiana Lines, Mr. E. A. Johnson, Engineer Bridges, Illinois Central Railroad and Mr. J. C. Nichols, Bridge Engineer, Louisville & Nashville Railroad.

BE IT FURTHER RESOLVED, that the thanks of the association be extended to Mr. L. A. Loggins, President of the American Railway Engineering Association, Mr. P. J. Wolf, President of the Association of Track & Structure Suppliers and to the Pick-Congress Hotel and staff for their cooperation, courtesy and hospitality shown to us during the period of this convention.

BE IT FURTHER RESOLVED, that the thanks of the association be extended to all those persons who have contributed to the planning and arrangements of this convention, to the Simmons-Boardman Publishing Corporation for their excellent news coverage; to the members of the National Association of Railway Business Women for their assistance in registration, to all Committee Chairmen, Vice Chairmen, and members who have submitted interesting and informative reports and finally to our retiring president, Mr. J. M. Lowry, who has guided and directed us so ably and efficiently during this very busy and unusual, but most profitable, convention year.

F. W. Hutcheson, *Chairman*
H. A. Matthews
Shirley White

Remedial Measures to Restore Damaged Bridges

One of the highlights of the Bridge and Building convention was a symposium on "Remedial measures to restore damaged bridges." This feature was held on Wednesday morning, the last day of the convention.

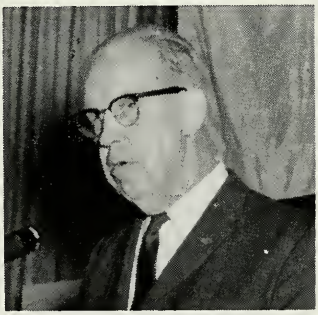
The symposium consisted of two talks—one by E. A. Johnson, engineer bridges, Illinois Central, Chicago; the other by J. C. Nichols, bridge engineer, Louisville & Nashville, Louisville, Ky. Both talks were illustrated with slides.

Mr. Nichol's talk

This presentation covers the restoration of Louisville & Nashville Railroad Bridge 188 spanning the Tensas River 16 miles northeast of Mobile, Ala. This bridge was severely damaged by a derailment on the night of Saturday, April 28, 1962, and resulted in blocking all rail traffic for 10 days.

Bridge 188 is of modern design and consists of eight 231-foot, single-track, Warren-type, through-truss spans and one 300-foot, Warren-type through-truss swing span. founded on concrete masonry abutments and piers. It was constructed during the years 1927 and 28. Six of the 231-foot spans were located north of the swing span and two to the south.

A shifted load of concrete pipe on a flat car located about one-third of the distance from the locomotive in a 142-car fast freight train headed south on the main line to Mobile, struck a signal tower near the north end of the bridge, then struck the end post of the first through-truss span, causing the



E. A. Johnson
Illinois Central

J. C. Nichols
Louisville & Nashville

derailment and piling up of some 40 cars in the nine steel spans and spilling several cars into the river. Only six of these cars were empties. The estimated speed of train was approximately 44 miles per hour when the derailment occurred.

A joint field survey made by the engineering forces from the chief engineer's and division offices revealed extensive damage to the entire structure, with particular concentration of damage to the first three spans.

The load of concrete pipe which struck the signal tower just north of the bridge also hit the end post of the first truss span and led to the derailment and piling up of cars throughout the length of the bridge. After the wreck the cars were found to be either piled up, bunched together or shoved through the truss members of spans 1, 2, and 3 with some cars partly resting on the bridge and in the river.

Span 1: Major truss members were severed or badly damaged, including four hangers, one vertical post, three diagonals, one collision strut on west truss; one end post, one hanger, three vertical posts and five diagonals on east truss. Floor beam brackets and vertical gusset plates damaged at five panel points. Both bottom chords slightly bent and distorted and intermediate portals damaged. All ties broken or badly damaged.

Span 2: Floor system completely demolished between panel points L4 and L7 and bottom chord severed on west truss between these same panel points. Members U5-L5, U5-L6, U6-L6 and U7-L7 severed or badly damaged in both trusses. U3-L3, U7-L6 and traction strut on west truss span damaged. All ties on span broken or missing.

Two hangers, two vertical posts, two diagonals and traction strut severed or damaged on east truss. Bottom chord on east truss distorted and bent between panel points L4 and L8.

Span 3: Two vertical posts, two hangers and two diagonals damaged on west truss. Top flanges and portion of webs on six intermediate floor beams bent three to six inches. All stringer laterals except those in end panels bent and damaged. All ties broken. This span was knocked transversely three inches. Two hangers and one vertical post damaged in east truss.

Spans 4, 5, 6, and 7: All ties on spans 4, 5, 6 and three-fourths of those on swing span 7 were broken or badly damaged. Hanger U1-L1, diagonal U1-L2 and post U2-L2 on north arm of east truss of swing span 7 were severely damaged.

As a result of this inspection, the decision was reached that in order to handle rail traffic span 2 was to be dismantled and replaced with a temporary timber trestle, falsework was to be placed under spans 1 and 3 to support the floor systems and three damaged truss members on the swing span were to be replaced. Repairs were accomplished

for the restoration of this bridge by carefully planning each step.

Here is the procedure followed:

Span 1: Derailed cars removed by L&N's on-track wrecker and crane. Lower chords falseworked to support floor system, using blocking from ground line at three panel points and driving a cluster of four piles spaced on four-foot centers with floating driver at all other intermediate panel points. Piles capped and falsework blocked tight under lower chords and floor beams. Ties and rail replaced as work progressed toward span 2.

Spans 8 and 9: Derailed cars removed by L&N's on-track wrecker and broken ties replaced.

Span 7 (swing span): Damaged ties replaced on south arm of swing span. One derailed car removed by L&N's on-track wrecker. Ties replaced on north arm, using Burro crane. Panel points 1 and 2 on north arm of east truss falseworked. A cluster of four timber piles spaced on four-foot centers were driven with floating pile driver at these panel points. Piles capped and temporary blocking placed under lower chord at above points. This work permitted the handling of heavy equipment over draw span, permitted the opening of draw for passage of river traffic and the removal and replacement of three damaged truss members.

Spans 6, 5, and 4: All broken ties were

Forty cars of the 142-car fast freight train piled up on L&N's nine-span truss bridge over the Tensas river near Mobile, Ala.

replaced on these spans up to derailed cars on north half of span 4, using Burro crane. L&N's on-track wrecker removed derailed cars on span 4 and Burro crane replaced remainder of ties up to span 3.

Span 3: A cluster of four timber piles spaced on four-foot centers was driven at all intermediate panel points with floating pile driver. Due to severe damage to all intermediate floor beams, eight 8-inch by 16-inch-long timber stringers were placed parallel at each intermediate floor beam with ends founded on pile clusters, and falsework securely blocked under ends of all steel stringers and at lower chords. Demolished cars were removed with floating equipment and derailed cars with L&N's on-track wrecker. All broken ties replaced with Burro crane up to span 2.

Span 2: Work on this span was progressed at the same time as on spans 1 and 3. A cluster of four timber piles spaced on four-foot centers were driven at five intermediate points and a six-pile cluster driven at another panel point with floating pile driver. Piles were capped and falsework blocked up securely under lower chords of both trusses to stabilize this span while being burned down. Large sections of the trusses and floor system were cut by acetylene torch, handled with a floating crane and placed on barges. This span was replaced with a temporary open-deck timber trestle, using four-pile bents spaced on 12½-foot centers with three 8-inch by 16-inch timber stringers per rail. Piles were driven with the road's on-track pile drivers working from each end of span 2 and material handled from the barge with the floating crane. Demolished cars and other debris on this span and in the river were removed with the floating crane and

Falsework was required before several trusses could be repaired.

placed on a barge. A tank car containing sulphur dioxide was salvaged from the river at this location.

Equipment and personnel other than the railroad's used in removing wreckage, handling certain material, driving piles, dismantling span 2, are as follows:

(1) Ernest Construction Co., Mobile, furnished two floating cranes with crews and supervisors and were used as pile drivers to work with railroad forces in driving piles and placing falsework for support of the damaged spans.

(2) The Atlantic & Gulf Stevedor Co., New Orleans, supplied two floating cranes, each with necessary crew and supervisor, also manpower for operation of its own tug, cranes and barges. These floating cranes removed some 30 of the derailed cars and other debris from the bridge and the river and assisted in handling the large sections of cut up steel in the dismantling of span 2.

(3) The American Bridge Division of the U. S. Steel Co. supplied supervision and steel workers for dismantling span 2 and the removal and replacement of the three damaged truss members of the draw span.

(4) The Mobile Ship Repair Co. supplied a floating crane that was used to remove some of the derailed cars from span 3.

All temporary repairs were carried out by the railroad's division forces with headquarters at Mobile. Assistance at supervisory level came from the chief engineer's office at Louisville.

The work was organized into two 12-hour shifts per day. Frequent conferences were held by the railroad's supervisory forces and representatives of the various contractors to discuss the work and the progressive steps to be taken.

To simplify the planning of the work and the recording of its progress, all supervisory personnel were furnished an outline of the work to be done, including simplified drawings of each span. This outline provided space to mark the progress and to record the dates on which the various items of work were completed.

The rapid progress of the repairs which enabled the bridge to be opened to traffic in such a short time was the result of the following favorable conditions:

(1) Close cooperation between all parties involved on the job.

(2) Availability of a large emergency stock of timber material at Mobile, which was moved on barges to the bridge site for use as required in making repairs.

(3) Availability of good equipment, both from the contractors and the railroad.

(4) Perfect weather.

(5) Sufficient depth of water (16 to 18 feet) which permitted unrestricted use of floating equipment.

Other aids used included a floodlighting system, walkie-talkies, numerous small boats and a professional diver.

The bridge was opened for traffic at 11:40 p.m., May 8, 1962, just 10 days after the derailment. Speed of all trains was held to 10 mph.

The damaged portion of this bridge was replaced with nine 75½-foot, single-track, deck-girder spans, founded on present masonry piers and abutments and on six new concrete-pile piers. Completion date was August 30, 1963.

Mr. Johnson's talk

The restoration of damaged bridges could be a very broad subject, but I will confine my presentation to emergency situations—steps to be taken to organize restoration operations and the obtaining of the necessary materials, equipment and men to accomplish the restoration. Usually, the prime consideration is to close the gap between rail ends, to permit the resumption of traffic as quickly as possible.

Of course, you are all aware that emergency situations involving bridges can be caused by many things. Some of the more common are washouts, scour undermining supports, burnouts, drift, derailments, tornadoes, hurricanes, runaway water craft, shifted loads, etc.

It seems that these emergencies always occur at night, over the weekend or on a holiday, and usually at a time when the weather is most severe and unfavorable. Furthermore, it is not usual that the first report you get of damage is sketchy and inaccurate. It was only recently that the first word I received located the damaged structure where we have from two to three bridges per mile. The second report indicated that the derailment took place some five or six miles from the first location in a straight track area without bridges; but it was only a matter of another hour or so that we had pin-pointed the location at a truss bridge.

Even though the initial reports do not give you the extent or details of the damage, there are many things to which you can give your immediate attention. If a timber bridge is to be restored, the procedure is usually less complicated than with a permanent-type structure, but it does involve a review of office records, particularly those pertaining to penetration, from which piles of proper length can be ordered. Before ordering timber, the question of redriving with new piling or cutting off and framing on the old pile stubs must be resolved. Usually, replacement in kind with treated material will be the more satisfactory, and ultimately the most economical.

Concrete damage requiring emergency repairs or replacement is usually confined to the substructure, piers and abutments. If the pier has been damaged by fire, probably

all that is immediately required is removal of the damaged concrete and the bridge seat leveled up to take timber blocking. If a pier has been washed out, temporary replacement will probably be by pile piers to support a steel span, usually I-beams, straddling the concrete-pier area. If the original superstructure can be reclaimed, the I-beams will have to be of sufficient strength to support the end bearing of the superstructure.

When a steel bridge is involved, the problem of restoration is obviously more complex than that of timber. The damage is usually more extensive and assistance will be required from the bridge office. Although my following remarks will be directed primarily toward steel-bridge damage requiring emergency restoration, nevertheless, many of the questions and statements pertain to other types of structures as well.

Check all information you have on a structure by reviewing your files, plans and inspection reports. Determine the dead-load reactions, weights of individual members, the type of foundation, etc. Is the bridge on rock or piling? If on piling, what is the nature of the underlying material? Will long piling be required or will minimum penetration be sufficient?

As soon as the pile lengths have been determined, advise the stores or purchasing department of your needs, so that they can check their stock. If they cannot furnish exactly what is required, they may be able to furnish acceptable substitutes or they may have to arrange for purchase. Second-hand bridge timbers and ties are usually available on the division. These should be loaded and shipped for use as blocking or cribbing.

Check the labor situation with your division people. Do they have a sufficient force available or will men have to be moved in from other locations? A whole line steel bridge gang or gangs will normally be required. These gangs are usually self-sufficient, as far as tools and equpiment are concerned. These, and many more questions can be answered, even before knowing all of the details of the damage.

Of course, it is desirable to know the degree or extent of damage as early as possible. If the trusses or girders have been knocked off the supporting piers, or a pier has been washed out, will it be possible to reclaim and re-use the old spans? Will it be possible to restore the steel on the old piers, or will the removal of the old steel be necessary before the opening can be bridged?

In the case of a derailment, there are many questions, including those I have just mentioned, that cannot finally be resolved until the wreck is cleared, so that the damaged structure can be inspected. Furthermore, quite often work of reconstruction cannot be started until the wreck has been cleared, but during this period, you should be planning your method of restoration by anticipating the various conditions which could exist.

On a single-track main line where detour arrangements are not good, the prime consideration is to close the gap with the greatest possible speed. If the damage has occurred in double-track territory, every effort should be made to get one track open, after which consideration can be given to the restoration of the second track by a more permanent-type bridge replacement.

The method to be used and the permissible time limitation to restore a main-line or a branch-line bridge could vary a great deal, depending in a large measure on the availability of a good detour route. A good detour route will reduce the pressure in connection with getting the line open. It may permit working the men only during daylight hours—possibly not more than two shifts and not over 8 to 10 hours to a shift. The efficiency of labor at night under poor lighting conditions does not approach that of labor working during daylight hours. The quality and quantity of work done during daylight is vastly superior to that done at night.

The cost of restoration is important. It is just as important to save money in this type of an operation as in any other. There are many locations where the cost of detouring trains, or time lost in moving trains, is not excessive. At such locations, long hours of overtime at penalty rates should be held to a minimum.

The removal of wreckage is usually the responsibility of the mechanical department; but it is well [*for representatives of the engineering department*] to be on hand during this operation to see that unnecessary damage is not done to re-useable bridge units.

There is not enough time allotted to me to go into details of equipment requirements, but when working at night have an electrician on the job to see that the generators and lighting system function at all times. It is during emergencies that otherwise reliable equipment develops trouble.

Abstract of Addresses Delivered Before the Joint Sessions

The first featured speaker at the joint session, held on October 14, was J. H. Lloyd, vice president operation, Missouri Pacific, who spoke on "Today is tomorrow." His address included the following comments:

Remarks by J. H. Lloyd

I consider an invitation to talk before and meet with a group of maintenance-of-way supervisors, such as this, a pleasure and wish for you the most successful convention that you have had. Your convention being held concurrently with the American Railway Progress Exposition gives each of you the opportunity to view the most modern equipment of today designed to meet the ever changing maintenance requirements of tomorrow. Maintenance is becoming one of the most interesting and fastest changing subjects in the art of railroading. Looking back over the events of railroad history one might well conclude that the past was the most interesting and the fastest moving. It certainly has been a period of accomplishment, but it has only paved the way for much greater advancements. True, the past was impressive, but, as necessity requires, we can change more radically in the next ten years and we must. If our present methods are obsolete, then we are the people to change them.

Recent equipment developments have been outstanding, still they are not adequate for today, because of the rapidly changing conditions which are creating a demand for cost savings, production line techniques and a trained organization to carry out specific plans. We have a strong need for track equipment that requires minimum maintenance and parts replacement. Knowing today's track problems, what can we as maintenance men do to help improve our situation and find answers to these problems for tomorrow?

First, we are being called upon to increase output and to operate on reduced budgets. Also the new equipment is adding new and increased maintenance problems. Perhaps, to solve these questions, we should ask ourselves if we have production control. Such control can optimize manpower and materials, and increases the availability of equipment. Have we adopted modern planning and scheduling techniques that assure completion of the projects? Have we scheduled our expensive machines 24 hours per day? If we have, are the hours scheduled in proper sequence? Do we need lining machines in our 24-hour surfacing gangs working 24 hours also? What system do you have for determining priority of work? If you have an industrial engineering group, and I am satisfied most of you do, I suggest you put them to work. The results can be most revealing.

After we secure proper scheduling, I suggest we insist on quality control. This means personal inspection, and, of course, this rests with you gentlemen. It is not a simple, easily-learned technique. Yes, we must have standards, and all of us must familiarize ourselves with them, and then, perhaps, the most important thing is to see that they are carried out. You cannot do this from a swivel chair.

My second challenge concerns prestressed concrete bridge and building construction. I hope you have all read the economics involved. Have we availed ourselves of all the opportunities of using this type construction?

My third challenge results from a recent issue of *Railway Age* which suggests a new approach for owning and managing railroad work equipment and roadway machines. Basically it involves setting up within the corporate body an organization that would rent the equipment to the using department.

This idea appeals to me, as we must not overlook the expense that accompanies our mechanization age. Idle machines carry the burden of ownership costs, such as interest, depreciation, obsolescence, etc. We no longer can afford to take the attitude that mechanization has paid its way and leave it at that. A system such as suggested would force the user of the equipment to estimate and control job costs more accurately because of rental rates. The user would be able to make an economic evaluation on a competitive basis. What would this do for management, you might ask? It would help determine the risk factor in appropriating capital funds for new equipment. It would help identify very quickly any specific type of machine that is not paying its way.

To provide the proper climate we need genuine two-way communications. It is apparent to me that employees want and need information. They do not like being uninformed. Furthermore, effective communication can be a key to employee motivation. Employees clearly want better communications. They want to feel they can get information when they want it, have access to the facts at all times. They are curious but also they want to do a better job.

It is true that we rail officers cannot experiment as fully as we used to. Union sponsored rules make it difficult to introduce new practices. But when each of these limits has recently been modified few officers have explored actively the possibilities, particularly the technological possibilities, which are now open to them. Railway officers seem too little interested in pursuing all the possibilities that technology might offer them.

The solution, as I see it, to this problem

is that we railroaders must accept technological competence as our major concern. We cannot be expected to pursue a course which offers gain primarily to others. If this change is to come it will have to come in part from other interested parties outside the railroads. This is where you supply people come in. Good communication between railway department heads and yourself will insure direct benefits to your industry as well. As with the introduction of any new device, the workers' attitude may be antagonistic. Habit patterns are difficult to change. We may consider only the short run implications and not realize that introduction of a new technique will make our industry more competitive. It is ironic that many of our people who would be benefited are reluctant to introduce or use a new development. We need your help to entirely revamp our maintenance procedures and use new tools so that we are performing better and at lower costs. The only reason railroads still exist today is because of the immeasurable technical skills, imagination and determination expended by all of us the last 25 years. We on the MoPac consider new ideas and technological improvement imperative in today's art of railroading. You gentlemen have an obligation to bring your improvement ideas to railway management. We depend on you to provide plans for cost reduction and improved equipment availability. Both supply and railway officers must work closely together as both are mutually benefited.

Mechanization will continue through the process of evolution. Nothing or no one can stop the constantly increasing momentum of mechanization. Ignorance, reluctance to change, selfishness and apathy may dam it up momentarily but it cannot be stopped. We must move with it or lose our futures to competition.

Our aim as railway supervisors should be to free our properties from increasing costs. Only adequate earnings can make it possible to buy modern machines. We need your imagination and ingenuity.

Remarks by J. H. McKenzie

Following Mr. Lloyd's address those attending the joint session heard a talk by J. H. McKenzie, president, St. Louis Southwestern. Mr. McKenzie discussed Japan's new high-speed Tokaido Line. His address was entitled "What you can do with the know-how if you have the Yen." Here are some excerpts from this talk:

I spent several days in August of this year with President Ishida and other officers of the Japanese National Railways in going over their new Tokaido Line, and it can best be described as simply fabulous.

The belt area between Osaka and Tokyo, which is more than 300 miles in length, contains 40% of the nation's population and 70% of the country's industrial output. The yearly increase in JNR's passenger traffic in this area has been as high as 7.6% and as much as 4.8% increase in freight business. There is simply not enough capacity left in sheir present trackage between Tokyo and Osaka to handle the business which consists of as many as 130 trains one way or 260 trains both ways a day, and with the poor highway system and insufficient automobiles, buses and trucks, they have no alternative other than to build more railroad. This, therefore, is the reason for the new Tokaido Line which they are estimating will have three times the capacity of the present line.

The new line is 320 miles long and is double tracked. It is 25 miles shorter than the present line. About 40 miles, or approximately 13% of the new line, is constructed in tunnels, of which the longest is about 4.9 miles. The total length of the elevated structures, including tracks on embankment, is 57 miles or 18% of the total length. There are 11.6 miles of bridges which comprise about 4% of the length of the line.

While all of the present railroad in Japan is 3-foot 6-inch gauge, the new line will be standard gauge, that is, 4 feet 8½ inches and the tracks will be spaced at 13-foot 9-inch centers. Except for station locations, the maximum curvature is 42 min and the maximum superelevation is 7.2 inches. The new grade is limited to 1.5% and vertical curves to a radius of 33,000 feet, and incidentally this looks rather sharp when the train gets up to 125 miles per hour. The rail will be 107 pounds to the yard and welded in one mile strings with insulated and expansion joints provided at each rail end.

Concrete ties with rubber pads have been used throughout, except at the insulated joints, turnouts and bridges where hardwood ties are used. They estimate the life of their wooden ties at ten years. The tie has more merit than the type of fastening used, and they may experience some difficulty in maintaining the clip devices which incidentally serve as rail anchors as well as holding the rail to the tie. Their engineers state that the concrete tie, not including the fastening device, was costing them three times that of a wooden tie, or approximately $8.35 each. The fastenings are costing them about $6.00, in addition to the cost of the concrete tie.

No timber trestles whatever are used on the new line and outside of concrete and metal culverts, their bridge openings consist mainly of prestressed concrete girders, plate girders, truss spans and many continuous truss spans. On spans below 80 feet in length, prestressed concrete girders have been used. Plate girders are used in spans from 80 feet to 120 feet in length. Most of the members on truss spans above the floor system are constructed with I-beams not using built-up or latticed members. They have used standard components to the extent possible in their

bridge construction, and truss spans vary from 130 feet to approximately 210 feet. Their bridges and supporting structures are all steel or concrete designed for 33,000-pound axle loads with impacts varying between 30 and 60%. This is about one-half of the load for which we design railroad bridges in our country. They permit shop welding but in the field connections have to be made with high tension bolts or rivets.

They found at extremely high speeds there was a noticeable impact coming off the embankment and onto the bridge. To overcome this and the unequal settlement that was obtained, the end of the embankment is being sloped towards the foot of the back side of the abutment making an angle of 45 degrees, and this space is then filled with gravel. They believe this will eliminate pumping action immediately behind the bulkhead and provide a much better transition from the softer embankment to the solid bridge. I do not know just how this will work out, but it certainly appears to be a sound and practical idea, and we may benefit by doing the same thing where we have poor embankment conditions behind abutments on our railroads. Their high speeds also eliminate using camber in any of their spans, and those that I inspected were completely level irrespective of the length of the bridge.

Their ballast is crushed stone and is entirely too large for making fine raises. It is graded down to about one-quarter of an inch, but has a high percentage of rock as large as 4 to 4½ inches.

The construction of the new Tokaido Line was commenced in April, 1959. They expect to have it complete by July of next year and in operation for visitors coming to Japan for the Olympic Games. When I was in Japan in August, they had only a few short stretches of the line complete, including the 23-mile test section just north of Odawara. While work is going on continuously over every section of the line, it is difficult to see how they can possibly complete the work remaining between now and next July.

The line as described above was estimated as far back as 1961 to cost about $485,000,000. It is now estimated to run in the neighborhood of $900,000,000 and will no doubt exceed the billion-dollar mark before it is completed. In the 320 miles between Tokyo and Osaka there will be ten intermediate passenger stations but only two intermediate freight depots. The super-limited express trains will stop only at one of the intermediate stations, that being Nagoya. The traveling time for these super-limited express trains over the 320 miles with the one station stop will be three hours flat, and four hours for the limited express trains which will stop at all ten stations.

For the freight trains using the line, it will take 5½ hours to make the entire distance of 320 miles. While the schedules of their passenger trains call for maximum speeds of 124 miles per hour, the maximum speed for freight trains will be about 80 miles per hour. The passenger trains will have the line exclusively for their operarion from early morning to midnight. Between midnight and early morning, the line will be used for freight trains. The minimum headway permitted will be five minutes as compared to two minutes on some of their commuter runs now operating into the Tokyo station.

The new line is designed for maximum speeds without restrictions and there are no crossings at grade whatever for the full length of the line. All trains to be operated on the new line will be multiple unit electric rail cars. This will be true for both passenger and freight trains. Passenger trains, as previously stated, will consist solely of motored coaches. The cars will be 80 feet long and seat 100 passengers. Their reason for using electric rail cars as compared to the conventional locomotive trains is that it permits lighter type of construction and less maintenance on track, because the weight of the train is lighter with the motive power distributed over the whole train and the load shared evenly by all axles. For this reason, they were able to design all of their bridges and structures for axle loads not exceeding 33,000 lbs.

The maintenance of the track presents a most difficult problem on the new line on account of the traffic that it will be carrying. The basic plan is complete track removal on a 10-year cycle with a 2-year cycle general overhaul. The track work will be accomplished during the three-hour headway every midnight and the eight-hour headway once a week which is set aside by suspending freight operations.

In closing I would like to say that while the JNR's objective is entirely different from ours in trying to handle more passengers in less time and with freight operations more or less secondary, they are doing a wonderful job in meeting their problems. I sincerely hope that they are able to complete the work and have the new Tokaido Line in operation for the Olympics next year. I believe it will attract as much interest and attention as the Olympic Games themselves.

Improved Bridge and Building Tools Where Are We? What Next?

Report of Committee

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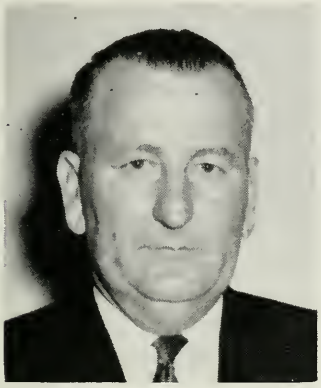


P. E. Scites
Chairman

The bridge and building gang of the present day cannot function efficiently without making full use of all the improved tools and equipment that are available on today's market. The increased labor rates and subsequent reduction in man-hours available has forced the complete mechanization of these gangs in order to accomplish the required maintenance work.

Improvements have been made and some new tools developed during recent years, but it is felt by many observers that these developments pertaining to tools for bridge and building use have not kept pace with those available for roadway and track purposes.

Where are we?

It will not be within the scope of this report to enumerate all the tools now available for bridge and building work, but merely to call attention to some of the more recent improvements and developments through which we are able to produce greater efficiency with the limited manpower available for our bridge and building gangs.

The most important improvements we believe have come through the changes made in weight and style of the so-called standard tools that have been with us for a number of years. These include power saws, drills, impact wrenches, hammers, breakers, jacks, wood borers, grinders, etc. Many of these have been reduced in weight and size by the use of alloy metals and other technological developments. Many have also been designed for higher speeds and greater durability.

The chain saw is a prime example of improved weight and design. When first put on the market it was strictly a two-man tool. At the present time, this type saw is available for one-man operation in a variety of sizes with either self-contained gasoline-engine drive, or for power take-off from units furnishing pneumatic or electric power.

Another improvement of note is in the impact wrench. When first introduced, these tools were heavy and required gauges for checking torque setting. Now they are available in much lighter weight and smaller sizes and with positive torque setting. Bolt tightening can be accomplished much more quickly and easily with these improved tools. The wide use of high-tension bolts in place of rivets has increased the use of impact wrenches to a great extent by bridge and building gangs.

Portable hand saws have been made lighter in weight and more efficient cutting tools compared with the original models. By so doing, the cutting capacity has been increased without penalizing the operator with excessive weight.

Drills and hammers have also been improved in design and efficiency. The development of masonry drill bits for use with rotary drills provides faster and easier means of setting anchors, especially in the smaller sizes. Electric and pneumatic hammers are still preferred for drilling larger holes in masonry. Rock drills and paving breakers have been greatly improved in weight and design, thereby providing higher operating efficiency.

Recently there have been placed on the market electric rotary drills in the smaller sizes with built-in power units. Power is derived from a small storage battery which will operate about six hours without recharging. Your committee does not have sufficient information to evaluate this tool at the present time but feels that it has merits for use in certain locations.

A tool developed in recent years has proven to be of help to gangs engaged in steel repairs, provided electric power is available. This tool is known as the "magnetic drill stand." It will automatically clamp itself to a steel member in either horizontal or vertical position and thus provide faster and more accurate field drilling.

Hydraulic powered tools have been developed in recent years that have a very definite place in bridge and building work. These operate smoothly and efficiently and are very powerful. Bolt pullers, bolt cutters, chord movers and jacks are essential for gangs engaged in bridge and trestle work.

Special attention is called to the newer type of hydraulic jack which will lift from either cap or toe position. These jacks are compact and fairly light in weight and have been found excellent for renewing bridge roller nests or any other similar operation involving the raising of girders. Power can be supplied from a small remote control pump which will operate two jacks simultaneously either up or down.

Of course, we should not fail to mention the importance of larger tools and equipment operated by hydraulic power, which have been improved and perfected during more recent years. Winches, cranes, platform lifts and numerous variations of these basic units are available for use on trucks and many other types of mobile units.

Bridge and building gangs often need a suitable tool for compacting backfill, installing driveways, platforms, etc. Gasoline-powered vibratory compactors are now available that will deliver up to 4,000 pounds of centrifugal force at 7,000 vibrations per minute and will travel at a rate of approximately 50 feet per minute while compacting crushed stone, gravel, sand and similar materials.

A much wider use is now being made of spraying tools because of recent improvements that have been made in design and operating efficiency. Their chief uses are for applying fire-retardant coatings to timber bridge decks, painting steel bridges and other structures, applying roof coaters and also preheated materials for built-up roofs. Sandblasting tools have also been improved, which is leading to their wider use in steel and masonry cleaning.

There has recently been placed on the market a small pneumatic tool called the "needle scaler" for use in cleaning small areas of rust, scale and weld slag. It consists of a nest of 19 small rods that float free of each other at the contact end. These are secured to a replaceable circular cap in the gun. This tool seems to be very efficient for its intended purpose of cleaning small areas. There is a possibility, however, that this principal could lead to the development of a more efficient tool for cleaning steel.

We call attention to a number of so-called small power tools that are available, some of recent development, which are suitable for the shop man or where an individual is involved in performing a certain task. Power screw drivers, nail drivers, belt and vibrating sanders, sabre saws, metal cutters, punches and spot welders are all useful and time-saving tools. Not to be overlooked are the smaller sizes of power drills with the many attachments available, such as hole saws, grinders, buffers, etc. These tools are inexpensive but very efficient and will pay for themselves many times over in labor cost savings.

Your committee feels that mention should be made of the more recent developments that have been made on our electric and pneumatic power units. While these are not tools in the exact sense, the correct operation of our power tools is dependent entirely upon them and their continuous and uninterrupted operation. Here again, much has been done to reduce the overall weight of the unit without sacrificing capacity. Improved design has increased efficiency and reduced maintenance, thus reducing shutdown time. Self-propelled or mobile units are available in sizes and capacities that will meet the needs of any situation.

The tools now on the market can all be classified as good and dependable tools, and each has an important use in its particular field. They have been developed and tested by the manufacturers before being offered for sale, and, as a result, it is possible to obtain dependable tools from many sources. We would not attempt, therefore, to recommend the use of particular types of power tools but only to say that, whether they be electric, pneumatic, gasoline or hydraulic, they are all good for their intended purpose.

It is possible there are other tools now available which have been overlooked in this report, not intentionally, but from lack of information. There may be some new tools now being developed by railroad personnel in various sections of the country, for particular purposes, about which we have not been informed. If this be true, we trust such information will be made available on the convention floor at the close of this report.

What next?

In this age of automation and technical development, it is not audacious to say that the field for developing new and better bridge and building tools is unlimited. We are grateful for what has been accomplished in this field over the years but let us not be

satisfied with a "status quo" situation. Rather may we look to the future for something much better, something very new and perhaps something radically different. All forward achievements are the result of someone's dream, so perhaps it would not be amiss for us to do a little dreaming at this time.

It is a known fact that present-day methods of cleaning steel bridges are not satisfactory. Sand-blasting and hand cleaning are too expensive. Flame cleaning is a fire hazard. Why not develop an infra-red scaler or at least some method that will accomplish this type of work in half the time now required.

Mention has been made of recent improvements in the size and design of power units. These are still too heavy and cumbersome. We need compressors and generating units of sufficient capacity for multiple-tool operation that can be easily moved by not more than two men. In order to accomplish this, it may be necessary to seek a new source of power. In any case, capacity must be maintained.

Another field for research involves the combining of certain power tools to perform multiple tasks. Such a development could reduce tool inventory to a remarkable extent, for example, an impact wrench that would also serve as a drill, reamer and woodborer. A combination paving breaker, jackhammer, rock drill and tamper would indeed be a dream tool. Other suggested combinations might include spike pullers and spike drivers, bolt pullers and bolt cutters, as well as a universal grinder that would accomplish all types of grinding.

The committee feels that it would be highly desirable to have electric drills that are reversible especially for wood-boring. Such a development would provide a much safer tool in boring large holes. If the present conventional electric drill jams, it is a hazard to the operator unless properly used.

It is most generally agreed that the hydraulic jack is probably the smoothest and most efficient for heavy jacking operations. We need these in reduced size in order that one man may easily handle units up to a capacity of 100 tons.

A light concrete vibrator that could be easily carried by one man around concrete forms would be most desirable and useful on masonry jobs. This might be powered by a small storage battery built in the unit.

We would suggest finally the development of a self-propelled unit that would drill bridge and trestle timber guard rails, set and tighten the lag bolt and possibly drive spikes in running and guard rails all in one operation.

The thousands of acres of roofs on freight and passenger stations and on warehouses require periodic renewal at excessive cost. We must develop a machine which will spray a chemically inert foam which will conform to all types of surfaces and offer appreciable savings in the way of installation as well as permanent waterproofing. Such a foam must be light in weight, form a tough skin to resist hail, be easily applied by spray methods and have an indefinite life. Cost is important and must be minimized.

Too long have we depended on conventional tools for driving piles. We must develop the new sonic drivers now in their infancy to a point where pile driving can be accomplished by a small gang consisting of a foreman and not more than two men with a small on-off-track truck crane. Some means must be found to accurately predict pile lengths needed for the new heavier cars in order to reduce future maintenance expenditures for surfacing and lining open-deck-trestles.

New soil sterilants must be developed which will effectively "kill" all life in the ground around our trestles, including termites, borers, etc., in order to extend the life of our trestles and minimize fire hazards. The effective life of such sterilants must extend over several years to minimize reapplication costs. Perhaps some form of radiation might be harnessed for this purpose.

The time lag between reduction of a tree to a usable piece of bridge lumber is entirely too long, and involves too much labor, seasoning and preservation treatment cost. It should be possible to cut a tree, saw it into usable sizes and lengths after the use of some type of sonic or irradiated treatment to kill incipient dry rot, and transport directly to the point of use. Periodic retreatments with radiation might serve to extend its life indefinitely.

The decision to remove a piece of bridge lumber on account of decay or condition must be based on the inspector's judgment and experience. Yet, the only tools available to supplement such judgment are the drill and hammer. We badly need a reliable testing device which would indicate, even to an untrained person, the condition of a bridge timber. Such a device must incorporate some means of correcting for various degrees of moisture content and density.

The costs to maintain steel structures in a rust-free condition are presently exorbitant. It is a well-known fact that rust cannot occur except in the presence of oxygen, and, therefore, we must find some permanent type of coating which will adhere tightly to metal surfaces, even when coated with various types of paints. Such a coating must have an indefinite life, be extremely weather resistant and prevent oxidation. New metal alloys might be developed for future use which would weather to a skin-tight condition that would eliminate further oxidization.

The bridge and building supervisory officer of the future must be equipped with

an entirely new concept of inspection and maintenance machinery which will be designed not primarily to make his work easier and faster, but rather to eliminate such effort wherever possible.

These are but a few suggestions in this field, and we are certain there are many more in the minds of bridge and building men everywhere. It may be a fantastic idea today but tomorrow it can be a realistic time saver.

In conclusion, we would urge the members of this Association to continue their efforts and cooperation along the lines of seeking new and better means and methods of overcoming the increasingly complex problems in bridge and building maintenance.

Installation and Maintenance of Prefabricated or Precast Bridge Structures

Report of Committee

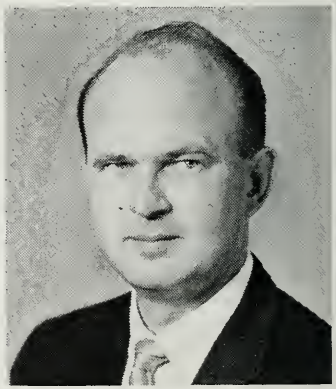
COMMITTEE—T. L. FULLER, *Chairman,* engr. brgs., SP, San Francisco, Calif.; A. L. PIEPMEIR, *Vice Chairman,* TURNER ENGINEERING CO., Nashville, Tenn.; M. M. RAY, JR., *Vice Chairman,* stud. supvr., StL-SF, Amory, Miss.; M. H. DICK, v. p. and editor, RAILWAY TRACK & STRUCTURES, Chicago; W. ENGLISH, draft., PRR, Chicago; R. A. GRICE, asst. b. & b. supvr., NYC&StL, Frankfort, Ind.; J. HEALD, sales mgr., NEBRASKA PRESTRESSED CONCRETE CO., Lincoln, Neb.; T. R. KINNEY, engr. strs., C&EI, Chicago Heights, Ill.; C. H. NEWLIN, engr. brgs., SOU., Charlotte, N. C.; L. P. NICHOLSON, field engr., PORTLAND CEMENT ASSN., Los Angeles, Calif.; J. C. ROBINSON, reg. engr., ARMCO STEEL CORP., Denver, Colo.; J. P. ROEBUCK, v. p. sales, AMERICAN CONCRETE CROSSTIE CORP., Tampa, Fla.; J. F. SCHMITZ, supt. b. & b., MP, Little Rock, Ark.; R. D. WHITE, div. engr., StL-SF, Amory, Miss.; J. R. WILLIAMS, engr. brgs., CRI&P, Chicago.

The report of this committee will cover only concrete structures, as inclusion of prefabricated steel or timber structures would make the report too voluminous. Reference will be made only to types of prefabricated or precast concrete structures presently in existence, planned or being researched.

The deck is the portion of a structure usually associated with prefabrication or precasting. Until recently, only one type of precast deck was available, namely, conventional reinforced concrete. Precast, conventionally reinforced concrete bridge decks have been in service for many years on American railroads, and more are being constructed each year. Some railroads purchase the precast decks from concrete fabrication plants, while others manufacture the decks in their own casting yards.

Generally, precast conventionally reinforced concrete bridge decks are of solid slab construction having two slabs per span. Due to the solid-slab construction, the dead load is quite large and span lengths are restricted to 25 feet or less. One railroad that has its own casting yard reports an average cost of $18.50 per foot for each slab, in span lengths of 16 feet to 24 feet.

Since March, 1954, there has been an alternative to conventionally reinforced concrete bridge decks. At that time trains of the Chicago, Burlington & Quincy commenced operation over a precast, prestressed concrete slab deck structure. This was the first precast, prestressed concrete railroad bridge in this country. The structure is single track, designed for E-72 live loading and is 18 feet 9 inches center to center of bearings. Since that time railroad bridges containing over 300 such spans have been constructed.



T. L. Fuller
Chairman

The prestressed structures are being built of three basic types: (1) The half-width slab, requiring two slabs per track; (2) the hollow box, requiring four or more boxes per track; and (3) precast I-beams with a cast-in-place deck made to act integrally with the precast beams for resisting live loading.

Span lengths have varied from 17 feet to 75 feet; however, the majority are between 20 and 30 feet. Committee 8-Masonry of the American Railway Engineering Association has prepared complete specifications for the design and construction of prestressed concrete bridges and is preparing standard plans for various spans, types of structures, etc.

There are advantages and disadvantages of each design of concrete deck, some of which are mentioned herewith. The advantages of precast, conventionally reinforced concrete decks are simplicity of formwork for the standard solid-slab units commonly used by many railroads, and the lesser amount of plant investment required than for a plant to make prestressed units.

The disadvantages of conventionally reinforced decks are the inherent inability of concrete to resist tensile stresses, resulting in approximately three-eights of the deck serving to space the steel reinforcement in the proper location. Thus, approximately 62% of the deck does not contribute to the bending resistance of the deck, yet it increases the dead load that the deck must carry. This high ratio of dead load to live load limits the spans for which these slabs can be used, as the high dead weight of the slab becomes an increasingly important factor on longer spans. Cracking is present in conventionally reinforced slabs at service loads and the presence of these cracks can permit the entrance of water and/or fumes which can cause spalling, deterioration of the concrete and exposure of the reinforcing steel.

Also the quality of the concrete used in conventionally reinforced slabs may be lower than that used for prestressed slabs as conventionally reinforced slabs are usually designed for 3000 psi concrete. These disadvantages are not peculiar to bridge decks alone, but are typical for all conventionally reinforced concrete members.

These problems are not new, having been in existence as long as reinforced concrete. The majority of concrete maintenance work is due to this inability of concrete to resist tensile stresses, although poor detailing practices and improper casting and curing also contribute to maintenance problems.

The advantages of prestressed precast concrete decks are the elimination of cracking (so long as loading does not exceed design assumption), and the reduction of dead weight due to 100% of deck resisting loading and the resultant ability to construct lighter, shallower spans of longer length than is possible with conventionally reinforced concrete. This results in savings of quantities of concrete and steel; the reduced depth of decks provide greater under-clearance and the lighter weight and longer spans permit a reduction in the number of supports required, thereby effecting additional savings in piling and foundations. The crackless concrete should be maintenance-free, as entrance of water and fumes into the concrete is prohibited.

The disadvantages of prestressed precast decks are the controls which must be exercised in stressing the steel to make sure that final strand tension is the proper value, the care with which prestressed members must be handled and the investment required in plant equipment, such as jacks, jacking anchorages, hardware, etc. Also, in longer spans (40 feet or more) the long-term effects of plastic flow in the pre-compressed concrete may result in shortening of the deck and increase in camber. Careful detailing is important to avoid cracking due to these effects. Due to the lack of uniformity of designs of prestressed decks and different plant capabilities, it is difficult to arrive at an average cost of prestressed decks. Other factors influencing costs are usage of existing forms, quantity of decks to be cast, the labor rate prevailing in the plant locality, repetitiveness of casting and stressing operations, handling, loading and transportation costs. With so many variables, it is difficult to state any average cost of precast, prestressed decks.

The substructure of a trestle-type bridge can also be of prefabricated, precast components. Concrete piling, both prestressed and conventionally reinforced, are in common usage. Sizes vary from 12-inch to 24-inch square and octagonal. The tentative AREA design utilizes three 24-inch square prestressed piles to support 28-foot spans. Prestressed concrete piling are reported to have superior handling and driving characteristics. The prestressed crack-free pile will eliminate problems occurring from corrosion of reinforcing steel and spalling of concrete due to the entrance of water through cracks caused by bending and handling stresses as is common with conventionally reinforced piles.

Pile caps are usually cast in place. This is done because a rigid connection between pile and cap is desirable. The usual method is to cut off the concrete pile at proper grade, leaving reinforcing bars or strands projecting. Prefabricated reusable forms are placed to proper grade, the reinforcing-steel cage is placed and the cap is cast and cured. Forms are then stripped and moved to another bent and the process is repeated. If hollow prestressed piling are used, usually the piling and strands are cut off to grade, a form placed inside the hollow core and steel dowels inserted in the core. Cap forms and reinforcing steel are then placed and the concrete cast.

Many structures in all parts of the country have been constructed in this manner. There are disadvantages of this type construction, namely the time required for field forces to place the form-work and reinforcing steel, the need to establish a batching and mixing plant for concrete (or to provide access for transit-mix trucks), providing a method of transporting concrete from the

mixer to the forms, the need to await the curing of freshly cast concrete, and stripping of forms.

These disadvantages can be overcome by the use of precast caps. The tentative AREA design recommends the use of a precast, conventionally reinforced cap having recesses in the bottom to receive the three piles and a 12-inch diameter hole from each recess up to the top of the cap. With this method of construction the piles are cut off to grade, the form is placed inside the hollow pile, the cap placed atop the piles and dowels placed through the cap into the piles. The cap is shimmed to grade and a small form placed around the pile at the bottom of the cap. Concrete or grout is then poured down the 12-inch hole, thereby anchoring the pile and cap together. With this type cap and pile-to-cap connection many of the disadvantages previously mentioned are overcome; however, pile-driving tolerances must be accurately maintained with this method.

Another method of utilizing precast caps has been used by one railroad. Caps are prestressed and have a steel plate anchored by welded studs into the bottom of the cap. On one project involving six bridge structures soil conditions were such that adequate penetration could not be obtained using piles of large cross-section, so spiral-welded pipe piling were driven and filled with concrete. Pilings were cut off to grade, a precast cap was placed atop the piles and the piles were welded to the steel plate. On this particular project the material cost of the caps was $240 each and the railroad states that this was considerably less expensive than the field pouring of caps.

On another project involving two bridges the same railroad used steel bearing piles, also welding the piles to a steel plate in the bottom of the cap. On a third project involving five bridges the same railroad used 18-inch octagonal prestressed piles, placed a structural steel bonnet over the tops of the piles, filled the voids between the exterior of the piles and the interior of the bonnet with an epoxy-resin grout and then welded the bonnet to the steel plate in the bottom of the cap. This railroad states that in all three instances the use of precast caps proved more economical than field-poured caps.

Throughout the preceding portions of this report there have been references to maintenance of concrete structures. Nearly all railroads have had problems with deteriorated concrete structures, such as concrete spalling and exposing reinforcement, cracking, water penetrating concrete and freezing, etc. For these reasons, many engineers are skeptical of the durability of the relatively thin-walled prestressed concrete sections. However, these doubts may be allayed when we recall the tremendous advances that have been made in concrete technology in the past decade. The use of air-entraining agents and higher-strength concrete have increased durability ten-fold. The concrete being cast today under quality-controlled conditions in casting yards is an entirely different material than the concrete of the past which is causing the maintenance problems. In addition, the very nature of prestressed concrete, due to all of the section being in compression, is virtually crack-free thereby eliminating the source of most maintenance problems. Prestressed, precast structures built today, properly designed and constructed, will be maintenance-free for many years.

What will be the future developments of precast bridge structures? Obviously the size of the future structures will be limited then, as now, by availability of lifting and handling equipment. In their search for the most economical structures, engineers will be examining longer spans in an attempt to reduce the number of units in the substructure and deck. The dead load of the concrete structure is going to assume even more prominence than it occupies today, and it will be necessary to refine design requirements in order to reduce the weight of the structure. AREA Committee 8 currently is engaged in full-size testing of box units that are hollow or voided for their full length, eliminating the solid diaphragms at midspan and the end blocks at the bearings.

If these tests show no adverse effects from elimination of these diaphragms, a reduction in weight of 3,150 pounds for each box 4 feet wide as shown on the standard AREA prestressed concrete trestle can be made. Since four boxes are required for each span, this weight saving could amount to 12,600 pounds. At first glance this does not appear to be very significant, but if you are attempting to handle this span working ahead with a locomotive crane, the reduction of 3,150 pounds at a radius of some 25 feet can be very significant. If end blocks and center diaphragms can be omitted, it will be possible to cast the boxes around a moving mandrel, the mandrel being withdrawn at such a rate that concrete has set before the mandrel clears. This will eliminate necessity of forming the interior void, which void form is not recoverable. The end result can be significant savings in the purchase of these box girders. The quest for reduced weight will possibly also lead to thorough investigations into the use of lightweight aggregate concrete for railroad bridge structures.

In summary, precast concrete bridges offer significant advantages to the railroad industry. Today's technology provides the know-how to design and construct concrete structures which will be maintenance-free, fireproof and long lasting. The advent of prestressing of concrete has particularly opened new fields to the bridge designers, as it is now possible to obtain long-span structures having all components made under controlled conditions in a casting yard, thereby, simplifying field

construction and installation. As the number of prestressing plants has increased and competition between plants has grown, the costs of prestressed units have decreased. With standardization of sections progressing, further benefits may be realized. The advantages of precast concrete bridge structures are such that their use should be seriously considered by any railroad contemplating bridge construction or renewal.

Construction Standards and Maintenance of Piggyback and Auto-Handling Facilities

Report of Committee

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W. H. Rankin
Chairman

The origin of utilization of one mode of transportation, such as a railroad, to transport another mode of transportation, such as a motor carrier, known as "piggy-backing", is obscure. Pictures taken in the 1860's show wagons and stage coaches being transported on railway cars. Ferry boats were the earliest method of spanning rivers and continue to serve railroads to this day.

Transportation of truck trailers on railway flat cars was inaugurated in 1926. For many years traffic was confined to common carrier motor vehicles. The innovation of container cars was also introduced in 1930.

Lacking precedence in this type of operation, railroads operated under a cloud of uncertainty until 1947. At that time a petition was presented to the Interstate Commerce Commsision for a declaratory order. This petition covered twenty points involving rates, division of tariffs, obligation of the railroads, and provision for interchange.

From this petition the following five types of "piggybacking" evolved.

Type I provides for rail handling of trailers of common carrier highway operators. This service extends from ramp to ramp.

Type II provides for the railroad to furnish both truck trailer and railway car. The railroad solicits the business and provides complete service from shipper to consignee.

Type III calls for the shipper to provide the trailer, owning or leasing as he wishes. The railroad provides the railway car and transports the trailer.

Type IV provides for the shipper to furnish trailer and railway car. The railroad delivers the car to a specified ramp.

Type V provides for joint rates and routes to be established for through movement of freight by truck and trailer on flat car.

Available records from 1955 indicate a growth of almost 400% in number of railway cars handled for piggyback operations, there being 168,150 cars handled in 1955 and upwards of 650,000 cars in 1962.

Initial piggyback operation by railroads consisted largely of the transportation of highway trailers or containers. In the mid-1950's an innovation in railway equipment was introduced. This being a multi-level flat car with fastenings to secure automobiles.

This type of equipment has accomplished a great recovery of business lost by the railway industry. While the transporting of highway trailers is only a partial recovery of traffic or sharing in traffic that would not otherwise be handled by railroads, this new equipment offers a method for total recovery.

Whichever of the five types a railroad may use, the need arises for special facilities to load and unload shipments. After investigation of the potential traffic and routes which will afford clearance, the management decides on the type of piggyback operation their road desires to use. Should the volume of traffic be adequate, the type of facility should be designed for and built of material suitable for a permanent installation. This minimum volume of traffic should continue for the anticipated life of the facility constructed. With the rapid increase in piggyback traffic, provision for expansion of facilities should be considered. There are many instances of temporary installations becoming permanent in nature, and of permanent installations being expanded.

For isolated shipment of trailers or automobiles improvised rolling equipment has been used for loading facilities. One method has been to remove the truck from one end of an ordinary flat car and grade an earth approach or construct a timber approach. A flat car with a steel ramp on it has been moved to locations of existing end-loading freight docks to provide an unloading facility for automobiles on multi-level cars. Portable ramps which can be towed into place can serve temporarily in any location. This represents an expensive item of equipment rather than a structure.

In addition to loading or unloading ramps, some types of piggybacking require other facilities, such as catwalks along tracks, a storage area for trailers or automobiles, truck scales with scale house, truck garage, and an office facility. The actual requirements are determined by need and the volume of traffic to be handled.

Having developed a brief history and description of this service, we can investigate each facility separately.

Tracks and yard layout

To be attractive to shippers, the inherent advantages of both truck and rail transportation must be maintained in a piggyback operation. Speed of handling is paramount. For this reason consideration should be given to locations advantageous to both rail and truck operation. If possible, trackage should be used exclusively for piggyback operation. The tracks should be so located in the yard as to minimize switching and be adjacent to an area large enough to provide parking for the anticipated volume of traffic. This parking area should be readily accessible to through streets or highways. For multi-track layouts, tracks should be constructed in pairs on centers of 13 feet 6 inches or more as required with a minimum of 17-foot centers between pairs. This permits installation of catwalks along each track to provide a quick and safe walking area for operators who are loading or unloading shipments.

Additionally, electric circuits may be installed on the catwalks to provide power for lights to illuminate the fasteners on trailers or automobiles and supply power for electric impact wrenches. In warm climates these wrenches may be air powered. Catwalks should be of such dimensions as to provide clearance but permit stepping from walk to car floor.

Tracks should not be constructed of greater length than that required to accommodate eight to ten 88-ft cars. This requirement is established by the time required to back loaded trailers on the cars and for operators to walk from the parking lot to an automobile carrying car. For automobile piggybacking it is advantageous to have the parking area parallel to the tracks. Should the area be fenced, openings should be provided in the fence about every 200 feet. Tracks should not have a larger degree of curvature than that negotiable by the equipment anticipated for use. Should interchange with other lines be involved, investigation should be made of other equipment.

Regardless of the skill displayed by operators in backing automobiles off multi-level cars, some shippers insist they be driven off forward. This requires the use of a wye track or a ramp located in the center of tracks connected at both ends.

Discusion to this point has been predicated on the use of an end-loading arrangement. This is the predominant method. However, we will discuss briefly other methods at a later point. The majority of end loading is accomplished with ramps up from ground level to car-floor height, with the tracks placed at ground level. However, some installations have depressed tracks, with loading being accomplished from ground level to car-floor height. While this type installation offers the advantage of requiring less tractor power and may fit the topography of a site better, it introduces additional drainage and snow-removal problems.

Ramps

Regardless of the type and material of construction, all ramps should incorporate certain features. The height above top of rail should be adaptable to the rolling equipment used. The height for most equipment-handling trailers is 3 feet 6 inches. However, if the ramp is to be used for both trailers and autos this height should be reduced to 3 feet 2 inches. Hinge plates to bridge from the ramp to car floor must be provided. Careful consideration should be given to provide adequate fasteners and structural strength for

these as they have been a maintenance problem.

On most ramps the most acute maintenance problem is produced by trains backing into them. Should the same rolling equipment be used at all times wheel stops may effectively be used. However, these are ineffective if cars with different end overhang are used. Such a situation normally exists in interchange business. Bumping blocks, cushioned with rubber or springs, placed against the end of ramp appear to be the best solution to this problem. Grade on the ramp should be easily negotiated with the tractor and load being handled. If a break in grade occurs, the difference should not exceed about 7%. This will provide underclearance for most loads being handled today.

A level portion at least 14 feet long should be provided at the top of the ramp adjacent to the railway car. The roadway surface should be made of a material suitable for the weight and volume of traffic handled. For heavier density traffic a concrete surface has proved best. The finish on such surfaces should be such as to prevent sliding on a moist condition. While crushed rock is a less expensive and satisfactory surface for lighter traffic, maintenance costs are increased with its use.

Materials and method of construction vary with the cost of materials and the track layout. As most railroads maintain timber bridge stock, the use of timber is predominant. Although framed structures are in use, surfaced earth-filled ramps are more prevalent. Retaining walls for the sides and end have been made of timber restrained by rail, or timber posts tied with cable from side to side, steel bin-type walls, or concrete gravity type walls. For temporary or light service there are ramps with end retaining walls only with side slopes, and width of roadway being adequate to remain in place unrestrained. Earth-filled ramps with retaining walls are advantageous for multi-track layouts. Expansion of facilities is easily accomplished by extending the retaining wall and placing additional fill. Cost figures for ramps vary with the size of the ramp and the material available. The least expensive is earth fill, with the cost increasing progressively with earth fill in timber walls, all timber and concrete construction which is the most expensive.

Comparative costs range from approximately $1500 for timber to $2700 for concrete, these figures being for one track. The increased initial cost of concrete is partially offset by a reduction in maintenance.

For handling automobiles, ramps must sometimes be provided for loading from the ground onto highway auto transports. To get autos on these transports requires three changes in grade. The last grade descends to the lower level on the transport and the intermediate grade ascends to the upper level. These ramps have been constructed of welded structural steel with open grating runways or of precast concrete sections bolted together. While the weight requires heavy machinery to place, a durable and semi-portable structure is produced.

Movable unloading devices

Movable end-unloading structures are usually constructed of metal and are towed into place. Any track which is surfaced to top of rail elevation with timber or concrete is suitable for unloading. Some movable ramps are powered with electric motors or gasoline engines. Construction of this type ramp usually provides separate runways for tractor wheels. This arrangement is the source of maintenance to tires and wheels of tractors.

Most auto-handling facilities are served by movable unloading machines. These are usually powered with electricity. A hydraulic hoist which raises a metal platform to any desired level of the railway car is the usual design. These devices may be tire-mounted but rail-mounted is the predominant type. These are particularly adapted to multiple-track layouts as extension of rails provides for future expansion. If all types of piggyback operation are conducted at one location, the machine can travel over the ramp to all tracks. Should certain tracks be used for auto handling exclusively, these tracks may be raised to match the top of ramp and lower car-floor height normally used for auto handling railway cars.

Approximate cost of this type of machine is $5,000. Another type of movable machine, which is not for end unloading, is the straddle crane which travels over the piggyback car, lifts a load off the car and sets it to the side of the track to be towed away with a tractor. This arrangement requires specially designed concrete runways for the crane and an area between tracks large enough to drive tractors through. While the cost of such an installation is high, it offers many advantages and has economic justification. This method of handling requires less personnel with the least time to unload. Any shipment may be unloaded without the load in front being removed such as required in end unloading.

The required storage area is reduced as loads may be moved out as quickly as they are unloaded. Tractor handling is expedited as the ramp and railway cars are not negotiated with the tractor. Initial cost of the crane varies from $75,000 to $100,000. Operating costs and improved service offset this expenditure with an adequate volume of traffic.

Depressed tracks with side loading

Advantages of side loading installations are similar to those listed for straddle crane.

Depressed tracks, with the previously mentioned drainage and snow-removal problems, are usually provided. An additional problem is created by the use of special cars and equipment which restricts interchange to those lines having similar facilities. Side loading is not used as much as end loading.

Storage area

The storage area for trailers and automobiles which have been unloaded from railway cars and await tractors or auto transports for delivery to consignee, should be surfaced with material adequate to handle the weight and volume of traffic. A clean and mud-free area is particularly important for keeping automobiles in a suitable condition for delivery. Asphalt or concrete surfaces are recommended where large quantities of automobiles are handled. Adequate drainage is important if gravel or crushed rock surface is used. Proper drainage and compaction will prevent excessive rust and holes in the surface.

Arrangement of storage yards should provide for identification of the load to the proper consignee. This requires a marking system for parking automobiles. Such marking on concrete or asphalt surface requires annual painting. To prevent vandalism or theft, storage areas for automobiles are usually fenced and well lighted. Some have office buildings with closed television circuits and electronically controlled gates in fences. Such installations assist in identifying operators leaving the areas with shipments. Talk-back communication should be provided between the office and the storage area and the tracks with incoming or outbound cars.

Summary

The service life of present unloading facilities, estimated to vary from 20 years for timber to 40 years for concrete, will probably be adequate. Many roads hesitate to build more expensive installations which may become obsolete with the development of new rolling equipment or unloading equipment. A great potential exists for future traffic in piggyback operation. Facilities must be made adaptable to handle a variety of loads. Moving vans and mobile homes which are being towed on highways are a prime example. Many ramps do not now afford underclearance to unload such shipments. Speed of handling at terminals will become more important and new and more expensive methods may become necessary. The various types of equipment which usually accompany a new enterprise are in need of standardization. Standard car-floor height and end overhang would make ramp height and wheel-stop placement uniform. This would also make interchange between roads more efficient. The railroads must continue to improve and develop this productive method of transportation.

Rail Anchorage on Bridge Decks

Report of Committee

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Before beginning the discussion of this topic, it is appropriate to consider the general background of rail anchorage on jointed and welded rail.

The use of rail anchors is primarily intended to restrain the rail from longitudinal movement, and secondarily to distribute localized rail stresses over a length of track sufficiently long to absorb such stresses without appreciable displacement.

Operating conditions of track gradient, or of traffic moving in one predominant direction, are well-known causes of rail motion. These conditions may be such as to require heavy anchorage in order to properly restrain the rail. Presence of turnouts and crossovers, draw or swing spans, track scales, and other factors serve only to complicate these conditions.

There is another condition which occurs at all locations, regardless of gradients or traffic motion—that of temperature differential. This temperature factor affects all rail, both jointed and welded, although to a different degree.

The design of rail joints takes into ac-

count the effect of temperature, in that the hole slotting provides space for a given rail length to expand or contract, when the proper joint space is provided at the time of rail laying. With proper rail anchorage for each length of rail, in order to prevent translation of the entire rail, and proper joint space provided for future contraction or expansion of the rail, temperature stresses in jointed rail are minimized.

Installations of welded rail, and the few instances of field welding of jointed rail into long strands, cause complications of a more involved nature, insofar as temperature stresses are concerned. No space is provided by rail joints for relief of temperature stresses, and, therefore, such stresses must be absorbed through anchorage to the ties and ballast.

From a practical standpoint, it is almost impossible to provide true fixity for a rail through anchorage. The factors which prevent such a desirable condition are: Improper application of anchors; crushing of the tie fibers; slipping of anchors through loss of holding power; inadequate ballast section; heaving of ballast or subgrade through frost action or ground movement; and many others. Experience has taught that, although we can minimize pull-apart gaps in welded rail through good anchorage, these gaps cannot be held tightly closed.

From the foregoing it should be apparent that the anchorage of properly laid jointed rail need be only sufficient to provide for normal operating conditions of track gradient, traffic direction, tractive and braking forces, jackknifing effects, and other modifying local conditions. Such anchorage has been developed by the various railroads in accordance with their own needs, but underlying all other considerations is the fact that the joint gaps do provide a measure of freedom for the rail.

Proceeding from the foregoing discussion to the consideration of anchorage of rail on bridge decks, we must differentiate between the treatment of jointed rail with its inherent freedom of motion, and the different provisions which must be made in the case of welded rail.

Jointed rail laid on bridge decks will, in the absence of unusual conditions, adjust itself through freedom in the joint area to a more or less stable condition throughout the seasons of the year. If laid with tight joints, however, special precautions must be observed during the renewals and other work of a similar nature during warmer temperatures. The only anchorage usually found necessary is that which must be provided for tractive and braking forces and other special effects mentioned above. In the main, bridge designers have provided adequate capacity for stresses resulting from these effects, but have provided the maintenance officer with few guides for most effective placement of this anchorage. He has quickly learned to avoid placing rail anchors near expansion ends of girders or trusses, but other standards are not so apparent, although probably not so important.

The pressure of welded rail on a bridge introduces the additional effect of temperature to those considered in the earlier part of this report. It is a well-known engineering property of materials that when subjected to a change in temperature, expansion or contraction will result, unless adequate means of restraint are provided. Each type of material, such as steel, aluminum, concrete and timber, has its own "thermal coefficient of linear expansion" which is a measure of its reaction to temperature changes. By comparison with steel, concrete will react to temperature changes about the same amount, but timber will react only about one-third to one-half as much.

For a given rail section, the amount of expansion or contraction will depend on only two factors, namely the length of the rail, and the amount of temperature change. For a 39-foot rail, laid at 65 degrees F, the change in length when the temperature drops to zero is approximately 2/10 of an inch. If laid according to AREA recommended practice of leaving 1/16-inch joint openings, then the tolerance in the joint-bolt arrangement would permit the rail to contract about the proper amount before exerting pressure on the joint bolts, and on the bolt holes in the web of the rail, and in the joint bars. This shows that the bolt-hole tolerances in the rail and joint bars are adequate for a 39-foot rail, but if the length exceeds 39 feet, the range of contraction may exceed the capacity of the joint.

By way of comparison, a welded rail strand, 1,440 feet long, laid at 65 degrees, will shorten approximately 7½ inches when the temperature drops to zero. Even if laid with tight joints which would permit a total contraction of ¼ inch, the net contraction not provided for would amount to approximately 7¼ inches. Since such a gap cannot be tolerated, a total corrective force must be provided to stretch the rail, and this force amounts to more than 158,000 pounds for a 132-pound rail section. This force is too large to be absorbed by the joint bolts alone, and therefore rail anchors must be provided to restrain the rail. It must be carefully observed that the rail anchorage dos not relieve the force in the rail, but merely distributes it through the ties into the ballast throughout the length of the rail, and keeps it from concentrating in the joint area. If the same rail were laid with tight joints, and the temperature rose 65 degrees above the laying temperature, the total force would have been larger since there would have been no room within the joint area for partial relief through expansion. Assuming an average force of 160,000 pounds equally distributed

over a 132-pound rail section, the average rail stress would be approximately 12,350 pounds per square inch. Tests made by the AAR and reported in Volume 60 of AREA Proceedings closely substantiate such a stress level.

With the foregoing general background, we may proceed to consider the effect of anchorage of welded rail on bridge decks. There are two general types of decks to be considered, namely, open decks and ballasted decks. Special types such as solid concrete slabs with the rail anchored directly to the slab are so rare as not to be worthy of general consideration.

If ballasted-deck structures are provided a minimum amount of ballast, or if the ballast has poor interlocking qualities, there is apt to be insufficient longitudinal restraint for ties anchored to welded rail, for the ballast will shift under the ties, resulting in poor line and surface, and excessive stresses in the joint bolts and web holes. If adequate ballast of the proper type *is* provided to transfer the stresses to the supporting structure, then the problem resolves itself to a consideration of the stresses in the structure.

It is felt an adequate ballast section should be a minimum of 8 inches under the tie, cribs full to top of tie and shoulder extending 6 inches beyond end of tie. Ballast should be of type that keys into place and not that which would roll, such as round stone or gravel. With an adequate ballast section and proper anchorage of the rail to the ties it is felt the only consideration to be given to ballast-deck structures is, where practical, to keep rail joints off of the structure.

Open-deck structures are somewhat simpler for there is no question as to the adequacy of the ballast. Many roads follow the practice of fastening timber guards, usually 4 inches by 6 inches or 5 inches by 8 inches in cross section, to tie ends with lag bolts to preserve tie spacing, and adding drift bolts through timber stringers, or hook bolts to engage girder flanges, to preserve track alignment. For welded rail anchored to bridge or trestle ties with the accepted patterns of rail anchorage, these tie fastenings must be investigated for adequacy to withstand the heavy temperature forces which are present. In most of these instances, additional tie fastenings will be found necessary.

The effect on the supporting structure must also be considered. Transverse, as well as longitudinal, forces may occur, and adequate provision must be made to restrain the forces resulting from the anchorage of welded rail.

Timber trestles will expand or contract only one-third to one-half as much as steel. The differential temperature stress to be absorbed by the stringers might seriously reduce their carrying capacity, even if the rails and ties could be rigidly anchored to the stringers. For an open-deck trestle, having three-ply stringer chords composed of 9-inch by 16-inch Douglas fir stringers with a thermal coefficient one-third that of steel, supporting 132-pound rail subjected to a 65-degree temperature change, the total force to be absorbed by the stringer chord amounts to two-thirds of 158,000 pounds, or 105,400 pounds. This force results in an average compressive stress in each stringer of 250 psi, or about 14 per cent of the 1,850 psi allowable stress. The maximum compressive stress in the stringers in their top fibers is probably higher than the computed average stress, resulting in even more loss of capacity.

Steel bridges having ties firmly fastened, with welded rail anchored to the ties, theoretically expand or contract at the same rate as the rails, and therefore anchors serve little useful purpose. If several long spans occur in the same structure, the pressure of the expansion ends of such spans will nullify rail anchorage, and if a rail joint falls on such a structure, the lack of fixity at the expansion bearings might permit the entire temperature forces to fall on the joint with disastrous results.

The effect of track curvature must also be given consideration for structures in welded rail territory. Assuming a 132-pound rail on a 1-degree curve, with a 65-degree temperature differential, the direct rail stress is 158,000 pounds. The radial component of this stress is 28 pounds per foot per rail, or 56 pounds per foot of track. For a sharper curve, the radial force will be proportionately higher; a 10-degree curve will have a radial force of 560 pounds per foot of track. For bridge ties on 14-inch centers, the radial force per tie would be 65 pounds per degree of track curvature. Such a force might pull a girder span out of line, if not well anchored to the supporting masonry. Such a force might displace the supporting bents of a relatively high framed trestle, or cause separation of its component parts. Few structures are designed for such a heavy lateral effect in addition to other forces.

If the welded rail laid across an open-deck structure is allowed to move freely, little, if any, of the rail stresses would be transferred to the supporting structure. Some railroads do not lay welded rail on structures over 200 feet in length. No rail anchors are used on the bridge but additional ones are added to the approaches, usually every tie is box-anchored for distances of 200 to 300 feet. Other lines do not have this restriction but use special sliding joints if the length of the structure is over 700 feet and the curvature is more than 4 degrees. On structures less than 700 feet long no joints are allowed on the bridge or within about 300 feet of the ends of the bridge, also no rail anchors are used on the deck. On longer bridges where joints fall on the structure they are left unspiked to permit longitudinal motion. The

length of a structure determines the number of sliding joints to be used. This varies with the different railroads.

The obvious solution to the problem of anchorage of welded rail on structures is to prohibit such anchorage. On long structures, or on structures located on sharp curves, provision must be made for rail expansion or contraction, thereby eliminating all need for absorption of rail stresses in the structure, with resultant reduction of capacity and instability. The use of sliding joints in such cases is recommended, with proper anchorage of track on the approaches to the structure.

Concrete Restoration Techniques in Current Use on Railroad Structures

Report of Committee

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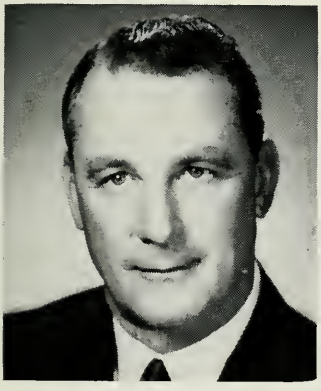

E. R. Simmons
Chairman

The purpose of the present discussion is to examine and report on "Concrete restoration techniques in current use on railroad structures"—tunnels omitted. This report will not include either the causes of or preventive measures for concrete defects, but rather will be confined to methods of repairing after defects have occurred.

In the compiling of this report, one fact was brought home again and again. Good concrete is assured by the conscientious application of a few simple rules. This criterion becomes increasingly evident as surveys are completed of concrete structures in service over a period of years. Those structures upon which these rules—largely matters of common sense and not intricate formula—have not been violated show up exceedingly well. Searching for some explanation of the sound condition on these structures, one finds only that the mix was not uncommonly rich, that the aggregates were clean and sound, that the mix was as dry as it could conveniently be placed, that thorough mixing was mandatory, that every placement was carefully rodded and tamped and good curing was had, that regardless of the refinement in strength and density to be obtained through the application of modern discoveries in aggregate proportioning and mix design, the production of durable concrete still rests on a few simple rules, conscientiously and sensibly applied.

The restoration of existing deteriorated concrete and masonry structures is a continuous problem facing our railroads today. Our B&B Association made a committee report on repairs to masonry structures in Vol. 63 of 1958, and therefore we shall try to avoid any duplication of this earlier report and describe only those procedures which are either new, different or improved upon.

Today when faced with making repairs to concrete and masonry structures, we usually have the choice of (1) conventional methods, (2) new methods because of special problems. In using either conventional or new self-designed methods we have to stick to certain fundamentals regardless of whether old-type materials are used or the newer ones. In most cases economics is the determining factor as to method and material, but there

are instances when time is all-important and therefore the design criterion.

Today we have a wide choice of materials for making concrete and masonry repairs. Based on economics and the time factor, each type of material has its own time and place for usage. The better-known materials are portland cement; cement additives to control shrinkage, bonding and quick setting; epoxy resins; and one of the latest—a latex modified concrete. In compiling data for this report, it was quite evident that the epoxy resins are gaining in popularity, and soon the physical characteristics of this product will be as well known as those of our standard type concrete.

Conventional methods of repairing concrete

Probably for as long as we have been using concrete, conventional methods for making such repairs have been developing through trial and error and good and poor results. Conventional methods are those which employ the usual materials and tools of concrete construction, but with a certain refinement of procedure which experience has taught is necessary for good results.

The importance of these procedures will be more evident if consideration is first given to the qualifications of a good serviceable repair or restoration:

(1) It must be thoroughly and permanently bonded to the older concrete.

(2) It must be sufficiently impermeable to prevent moisture reaching underlying older concrete.

(3) After drying it must be free of shrinkage cracks through which water could reach the supporting concrete.

(4) It must be resistant to freezing where this is a factor in weathering.

(5) It must be of good matching appearance in relation to surrounding concrete surfaces.

Bonding

The first step in obtaining a well-bonded repair job is preparation of the older concrete which is to receive the new material. Preparation involves: (1) removal of all unsound or damaged concrete; (2) shaping the excavation in such a way as to make the replaced material most secure; (3) cleaning and possibly pre-moistening the surfaces where good bond is desired.

Impermeability and freedom from shrinkage cracking

Today, with wide use and understanding of the role of entrained air in improving the resistance of concrete to many cycles of freezing and thawing, most important new work is thus protected and made much more durable by its use. But many older concretes face a continuing hazard from weathering, and thus present a serious problem in their restoration. Unless moisture can be kept from it, underlying concrete subject to freezing and thawing will continue to deteriorate with ultimate failure as a certain consequence. Restoration methods and materials then must produce a repair that is impermeable in itself and free from shrinkage cracks which will convey moisture to the inherently nondurable underlying old concrete.

Restoration of weathered walls, spillways, piers, bridges and particularly weathered portions of hydraulic structures may be carried out more safely and permanently if, after deep removal of the old concrete, a self-sustaining layer of reinforced, air-entrained concrete is anchored to the old concrete. With properly designed and located construction and contraction joints with flexible waterstops, such a wall surface can be made reasonably watertight. Moreover, its probable greater thickness, although not preventing low temperatures in the old concrete, will reduce materially the frequency with which its temperature rises above and falls below the freezing point.

Pneumatically placed mortar or some form of shotcrete is commonly suggested and often used for restoration work. Despite its serious limitations in many cases and the fact that it is by no means inexpensive, it is often chosen in preference to a thorough, deep-seated concrete replacement because of its convenience, facility and speed.

In facing such a decision, it would be extremely worthwhile to read the ACI standard "Recommended practice for the application of mortar by pneumatic pressure" (ACI 805-51). The implications, as well as some of the statements of this standard concerning the disadvantages and inspection of mortar placement by pneumatic methods, should be most carefully considered for restorations in freezing climates, particularly of hydraulic structures. Some are most pertinent to considerations of impermeability and minimum shrinkage cracking as important factors in arresting continuing deterioration under the repair.

Resistance to weathering

The most aggressive effects of weathering come from repeated cycles of freezing and thawing. In mortar and concrete, we can obtain greatly improved resistance to this by means of air entrainment. Shotcrete apparently is sufficiently dense that no report was found of its disintegration by freezing. Both concrete and shotcrete are subject to some deterioration from expansion and contraction from wetting and drying.

For many years, some maintenance departments have protected exposed restoration and new work with a linseed oil and paint treatment. Where it has been maintained it has clearly been beneficial as has been observed

on reclamation, as well as highway structures in the northwest. It is likely, however, that among the silicone treatments now available there are water-proofing systems which are at least as effective, but less costly in that fewer initial and retreatment coats are necessary and that the conditions of application are much less restrictive for good results.

Epoxies for concrete and masonry repairs

The most revolutionary technique in concrete restoration today appears to be realized through the use of epoxy resins. Epoxy resin compounds were first introduced in this country about 1949 and were early recognized as possessing a unique combination of properties in the field of plastics. These include: (1) Rapid hardening at normal temperatures from a liquid to a solid; (2) a high degree of adhesion to most surfaces; (3) a toughness which combines durability with resistance to cracking and superior chemical resistance to most acids, alkalies and solvents.

Epoxy compounds have been used fairly extensively as:

(1) Skid-resistant protective overlays and wearing surfaces on concrete floors
(2) Waterproofing membranes
(3) Patching compounds
(4) Crack and joint sealers.
(5) Adhesives for bonding both fresh and precast concrete to old concrete
(6) Grouting agents
(7) Paints for traffic marking, surfacing car-washing platforms, or as a general corrosion-resistant paint for concrete surfaces to prevent chemical attack
(8) Adhesives for bonding steel, brass and other materials to concrete
(9) As a shear connector in composite construction

These widely divergent uses and requirements clearly indicate that no single commercially available product could be compounded to perform all of these tasks well; hence, the term epoxy resin should never call to mind only one product. On the contrary, the versatility of these resins, especially with regard to compounding techniques, allows the formulator to produce a myriad of products having an extremely wide range of properties. A specific epoxy compound should be used only for the purpose it is intended. Wherever possible, the user should insist on field and engineering performance data to support the laboratory claims of the supplier.

Surface considerations

Two surface conditions must be met if an application is to be successful:

(a) The surface must be strong and sound.

(b) The surface must be surface dry and clean.

Extensive use of tests has shown that where proper bonding has been obtained over clean, dry, sound portland cement concrete, failure usually occurs in the concrete itself. Such failures indicate that the bonding strength of the epoxy compound is greater than the cohesive strength of portland cement concrete.

To check whether epoxy compounds can be applied below grade, or under circumstances where there is reason to suspect a condition of excessive capillary moisture or hydrostatic pressure, a simple test may be made. This consists of placing a piece of rubber mat on the surface which is held in place with a weight and allowed to stand 8-12 hours. If moisture has collected under the cover during this period, it is advisable to consult with the supplier to be sure the proper compound has been selected.

Surface preparation is approximately the same as that for other type patching materials—unsound material removed by jackhammer, sandblasting, acid-etching, etc.

Applying epoxy compounds

Epoxy compounds can be applied by brush, roller, spray, trowel, screed or squeegee, whichever may be the most convenient and efficient for the job. Several companies have developed excellent equipment for mixing and spraying epoxy compounds in a single operation. However, the use of such equipment can only be justified when large areas are to be covered.

At the time of application, the temperature of the epoxy compound should be between 70 and 90 degrees F. The temperature of the concrete surface onto which the epoxy is to be applied should be at least 60 degrees F. Below this temperature, there is likelihood of poor results because of poor wetting of the surface and an abnormally slow cure. Also, the epoxy may be hard to handle, since the viscosity increases rapidly with decrease in temperature. As epoxy compounds bond well only to relatively dry surfaces, it is necessary, on a job exposed to the weather, to halt application if it rains.

Methods for specific applications:

(a) Skid-resistant protective overlays

The epoxy compound should be spread uniformly over the prepared surface with brush, roller, broom or screed. Spray equipment may be used for large areas. Immediately after spraying, the aggregate (aluminum oxide, silicon carbide, silica sand, roofing granules or trap rock) should be broadcast (by hand or machine) over the wet epoxy compound at the rate of 1.5 pounds per square yard, using material passing the No. 10 screen and retained on the No. 20 screen for highways or material passing the No. 50 screen and retained on the No. 60 screen for industrial floors and car-washing platforms.

(b) Waterproofing

The epoxy compound may be applied by brush, spray or roller in at least two coats.

The second coat may be applied soon after the first coat has lost its tackiness and becomes hard.

(c) Patching

The epoxy compound is usually mixed with well-graded fine aggregate on the job. The aggregate used should be dry. The amount of fine aggregate used will depend on its gradation and the degree of workability desired. For thick patches, dry coarse aggregate may also be added. The top size of the coarse aggregate, if it is used, should be less than one-third the mean thickness of the patch. In horizontal patches the resulting epoxy compound mortar or concrete is applied by trowel or shovel and finished by screeding, floating or troweling. In all cases trial batches should be made to check the workability of the mix.

In patches on vertical surfaces, it is preferable to make a stiff mix of epoxy compound mortar or concrete so that it will have less tendency to flow or slump. To improve contact with the old surface, it is well to paint it with a mixed epoxy compound, containing no aggregate, immediately before adding the epoxy compound mortar or concrete. For large patches it will be necessary to hold the epoxy compound patch in place with forms which have been protected with polyethylene or cellophane.

(d) Crack and joint sealing

Joints in concrete which are not expected to undergo further movement may be sealed in much the same way as cracks. Large openings may be sealed either with an epoxy compound, epoxy compound mortar, or portland cement mortar bonded by an epoxy compound. In the last case, the mixed resin is sprayed into the opening to coat both exposed surfaces. Before the resin is hard, a 1:2½ portland cement mortar is pressed into the crack. For vertical surfaces this must be a dry-pack mortar, barely wet enough to hold together. When the mortar is about to take its initial set, the surface should be tooled with a mason's jointer or similar tool to force it more tightly into the joint.

Epoxy compound mortar may be forced into the crack in much the same manner. It may be desirable to spray the crack with an epoxy compound, as with the portland cement mortar.

(e) Bonding new concrete to old

Epoxy compounds used for bonding new concrete to old must be chosen from those formulations which develop adequate bond in spite of the water present in fresh concrete. The epoxy compound should be spread onto the prepared surface; if the surface is rough and irregular, the resin should be brushed in well to avoid air pockets. As soon as feasible and while the epoxy compound is still a liquid the portland cement concrete or mortar should be placed; however, if necessary, the bond coat may be allowed to remain exposed for a few minutes. If the epoxy compound has reacted sufficiently to lose its liquid state it will be necessary to apply additional epoxy compound to insure good bond. Concrete should be of a good quality, appropriate to the job and with a low slump. The concrete should be cured according to good concrete practice.

If the repair is being made on a vertical or inclined surface, forms may be necessary.

(f) Bonding hardened concrete to hardened concrete

Precast elements may be bonded to others or hardened cast-in-place concrete by preparing both surfaces for the receipt of epoxy compound, applying the compound to both surfaces, and pressing them together. Between vertical surfaces the viscosity must be such that the epoxy compound does not leak out, or provision must be made to retain it.

(g) Grouting

Steel dowels may be grouted by coating the prepared steel to a thickness of 15-30 mils, inserting the dowels into the cleaned grout-filled holes of the concrete, then twisting to insure contact. Grouting of voids in concrete or areas around steel may be done by adaptations of the methods described under Item (d).

(h) Coatings to prevent chemical attack

Such coatings must be applied in at least three coats, to eliminate "pinholing," which can ruin the whole benefit of the coating.

Hardening

As soon as the epoxy compound has been spread, it rapidly acquires the temperature of the surface onto which it was placed. For this reason, surface temperature should be checked before the epoxy compound is applied. Should this be less than 70 degrees F, hardening will be noticeably slow. So, when a fast cure is important, thought should be given to having the surface as warm as possible. Many methods of surface heating can be devised, but most are impracticable for large areas over thick concrete.

(a) Acceleration of hardening rate

Means for accelerating the hardening rate can be accomplished by:

(1) Use of a faster hardening system if available.

(2) Use of a black polyethylene film placed over the completed job to absorb solar heat.

(3) Use of infrared heaters placed over the complete job.

(4) Use of canvas tents and space heaters.

(5) Use of a torch played lightly against any metal surface being bonded to the adhesive. Localized and intensive heating must be avoided.

(6) Use of electrical, steam, or other heating elements permanently embedded in the cured epoxy resin compound.

(b) Deceleration of hardening rate

The slowing down of the hardening rate can be accomplished by:

(1) Lowering the temperature of the batch, or

(2) Spreading the batch out in a thin film.

Safety precautions

Two typical health problems which may be encountered when epoxy materials are carelessly handled are:

(1) Skin irritation, such as burns, rashes, itches, etc.

(2) Skin sensitization, which is an allergic reaction similar to that caused in certain people by wool, poison ivy, etc.

Make certain that manufacturer's safety precautions are rigidly adhered to.

Latex modified concrete

More recently developed than the epoxy resins are synthetic latex modifiers. These materials, added to ordinary mortar, provide equally great adhesive properties, along with good resilience, elasticity and durability.

Of particular importance in concrete repair work, latex modified mixes have also proved valuable for ceramic tile grout and bedding, coating for industrial insulation, and brick and concrete block mortars. As a concrete additive, the white, milky fluid combines with the customary sand-cement-water mix to produce a mortar that cures with high compressive and tensile strength, great flexibility, strong resistance to alkalies and dilute acids, low water absorption qualities, good freeze-thaw stability, and low in cost. Experimental mixes, depending on the cement-sand-water ratios, have yielded compressive strengths of up to 7,000 psi, shear, bond and tensile strengths of up to 1,000 psi, and flexibility of better than 2,000 psi.

Latex modified mixes have been used successfully to repair both concrete and wood sub-floors. In each case, the mix was used as a topping and usable in two days after placement.

One major experiment indicating the value of latex-modified mixes was on a three-span bascule bridge at Cheboygan, Mich. This 40-foot wide bridge had 116 feet of concrete roadway built in 1940, which had become badly scaled from weathering and de-icing salts, and polished by traffic. Unsound concrete was removed to allow for the placement of a minimum thickness of ½-inch latex-modified mortar. For test purposes, four methods of preparation were used. In one place, the surface was thoroughly wet with water. Another area was left dry and untreated. On a third, a bond coat of straight latex emulsion was brushed into the surface and dried until tacky. Finally, a slurry of latex and cement at 1:1 was broomed into one portion of the deck.

After one winter of use, it was found that nearly all concrete laid over a wet substrate remained intact. But in the areas prepared by the other three methods, there were varying degrees of failure. The faulty areas were cleaned again and new latex-cement mortar applied, this time over the deck washed and soaked with water.

After two winters of use, the following conclusions were reached:

(1) There was no bond failure where the substrate had been thoroughly soaked with water.

(2) Great fluidity is possible with fairly low water/cement ratios.

(3) Latex mortar is highly susceptible to skinning over and shrinkage crack formation if not immediately covered with wet burlap after the final finishing. Experience has indicated the need to adopt certain procedures with latex-modified concrete that vary somewhat from methods followed with conventional mixes. These are:

(1) *Surface preparation.* Approximately the same as for conventional mixes except area to be surfaced should be kept damp—even at time of resurfacing.

(2) *Mixing.* Latex loses its stability with air entrainment; hence, no air-entraining admixture. Two to four minutes mixing time —short pot life.

(3) *Placement and finishing.* Placement is approximately the same as for conventional mixes. Because of wet drag, latex mixes are often more difficult to trowel than conventional mixes. They also set more rapidly and form a surface skin that will tear if worked too hard. To facilitate troweling, the area can be rewetted with 50/50 latex-water.

(4) *Curing.* Wet burlap recommended for 2 to 3 days. Five days after the placement of latex concrete, the surface can be reopened to traffic.

Further experience with latex-modified mortars will add to the store of information about them, and possibly alter some of the procedures now recommended. As matters stand, latex modifiers put new muscle and durability into what has long been a standard building and road material. They permit a wide range of applications for tough, long-lasting concrete and at the same time can offer architects and contractors additional freedom in design and construction methods.

Practices by various railroads

As already stated, there is a time and place for all our accepted materials—also method of use. Any given railroad may be faced with problems of repairing either a concrete or masonry structure that are peculiar only to that given job. These are the times when the ingenuity of our engineers is used to the maximum.

Quite a few of our railroads have many cut-stone piers and abutments still in service that are over a century old. In most cases the mortar is gone, stones have fallen out, and the cap stones are either bad or have been replaced with concrete. One of our railroads uses its own forces in conjunction

with a contracting company which furnishes a job supervisor and one assistant, mixing equipment and special tools, their patented brand of non-shrink admixture and grout lubricating admixture. The railroad furnishes necessary men, sand, cement, steel, air compressor, pumps and other miscellaneous material.

The stones are drilled vertically from the top or, where needed, horizontally or at an angle to best tie them together, and ¾-inch reinforcing steel is placed in the holes. Where the stones are cracked and/or spalled, the unsound portion is removed. Dowel holes are then drilled in the surrounding sound rock and reinforcing dowel steel is placed in these holes. One-half-inch reinforcing steel is then tied on about 9-inch centers in the opening. The face is partially formed, crushed rock is placed in the opening, alternating forming and placing crushed rock until the opening is filled. Injector pipes are placed in the mass of crushed rock as the placing and forming takes place, and grout is pumped into the mass through them. This grout is composed of cement, non-shrink admixture, lubricating admixture, sand and water. The grout slurry thus formed completely fills the void spaces in the crushed rock, forming a dense concrete when cured.

Simultaneously, holes are drilled in the face of the structure at the corners of the joints, in a manner best described as crossing the T's and dotting the I's. Special expanding grout-injector tips are secured in the holes in each general area, alternating to other general areas as the work progresses, and a hose is connected from the pump to an injector. The grout slurry is then pumped into the structure under pressure which at times reaches 300 psi. Pumping progresses from one tip to another, from one hole to another, and from one general area to another. Obviously grout at times is forced through an external crack before having reached the desired internal faces. When this happens, the grouting operation is moved to another location, allowing the grout in the first location to "set". Later grouting is resumed at this location, which permits the grout to penetrate all interior surfaces and cracks, as well as all joints.

After the entire structure has been pressure grouted, and all defective stones and/or concrete have been either repaired or replaced, all surface joints are tuck-pointed. When this is done we have a tight, solid, uniform structure, now protected from increased weathering damage.

The above described procedure has also been successfully used on larger stone and masonry arch culverts.

One railroad had a 1940 harbor structure where many of the 14-inch octagonal concrete bearing piles had suffered critical losses in cross-section above and below the water line. The repairing technique consisted of removing loose concrete (divers doing the work below water) and wire brushing reinforcing. Two mating cylindrical forms of pipe were fitted around the pile, made watertight, and then dewatered. New reinforcing was placed where needed and non-shrinking concrete was placed in the caisson.

Where surface repairs are necessary to concrete structures, particularly when reinforcing is exposed, numerous railroads use the shotcrete method. Preparation of surface and the type of material used are conventional. Major difference is by use of a shotcrete machine to spray material on. For large surface repairs, it appears the shotcrete method is both practical and economical.

Our railroads have been making large use of the epoxies for concrete and masonry restoration work. *Railway Track and Structures,* in its issues of June, 1961, and July, 1962, go into detail on uses made of epoxies along with the economics. Therefore, we will not in this report repeat these procedures as the magazine is well known to our maintenance-of-way people.

A most interesting example showing the practicability and economy of using epoxies for repairing concrete bridges was the method used recently for repairing a 40-year-old concrete wharf at the Port of Los Angeles.

A recent inspection revealed structural cracks in a number of concrete pile caps and stringers. These cracks, varying in width from hairline up to 5 inches at the underside, were all normal to the longitudinal axis of the beams, dividing them into as many as eight pieces.

Rail traffic was immediately barred from the weakened wharf, and engineers were assigned to study potential remedies. Two solutions were proposed: (1) Removal of the concrete wharf deck, caps and stringers, etc., and replacement on the existing piles; and (2) restoration of the caps and beams by bonding them in place with epoxy resin.

The advantages of the restoration plan were considered to be:

(1) Repairs could be made without interrupting shipping operations,

(2) Substantial savings could be made, and

(3) The facility could be restored to full service much sooner.

It was decided to inject the liquid epoxy into vertical and overhead cracks by means of external pressure. This necessitated the use of some kind of surface sealant to contain the pressure. A puttylike proprietary epoxy containing inert fillers was selected for this purpose. The sealant epoxy had to be stiff enough to apply to overhead and vertical members without sagging prior to hardening. Ability to bridge the largest cracks with a bond strength sufficient to withstand internal pressures of at least 125 psi was also a requirement.

Following the selection of materials, laboratory and field tests were undertaken to qualify the epoxy healing agent and the manner in which it was to be applied.

An examination of the wharf structure had disclosed that several dozen 30 by 36-in. concrete pile caps were cracked across the entire beam sections in several places. Using an adjacent member of damaged concrete as a control, a typical cracked girder was selected for restoration and later static and dynamic loading. The beam had been completely severed by large transverse cracks (up to ½ in. wide at the bottom of the beam) in at least seven places. All cracks extended to the under side of the concrete deck which had been poured monolithically with the beam.

The total cost of epoxy repairs and shotcreting was $92,890. The estimated cost for removal of the wharf structures and replacement with new concrete was $350,000. Assuming the time needed to remove the existing damaged concrete wharf deck girders, etc., to be a full year, the loss of revenue on the facility would not have been less than $100,000. The apparent total savings to be effected by the epoxy healing method as compared with demolition and reconstruction has, therefore, been estimated at $357,000.

Conclusions

In this report we have covered the conventional methods of repairing concrete and masonry structures as well as a few which created special problems—also the conventional materials as well as the newer epoxies and latex-modified concrete.

After a review of the various methods and materials, it is quite apparent that in numerous cases there is no exact formula for making repairs—each project has to stand on its own merits. Usually, there are always two or more ways of doing a job. Assuming that the job has to be done, cost comparisons should be made between the alternatives, and method decided upon should be well-planned before work started.

Habit and past practice are creatures of the past. Whether standard cement, an epoxy, or a latex-modified concrete is used on a job (and there is a place for each), the main criteria for success are: (1) Thorough investigation and planning, (2) proper procedure according to instructions, and (3) the conscientious application of a few simple rules. These criteria to be based on satisfying present-day needs and not the needs of yesterday.

HISTORICAL INFORMATION

List of Annual Conventions

No.	Place of Meeting	Date	Membership
1	St. Louis, Mo.	Sept. 25, 1891	60
2	Cincinnati, Ohio	Oct. 18-19, 1892	112
3	Philadelphia, Pa.	Oct. 17-19, 1893	128
4	Kansas City, Mo.	Oct. 16-18, 1894	115
5	New Orleans, La.	Oct. 15-16, 1895	122
6	Chicago, Ill.	Oct. 20-22, 1896	140
7	Denver, Colo.	Oct. 19-21, 1897	127
8	Richmond, Va.	Oct. 18-19, 1898	148
9	Detroit, Mich.	Oct. 17-19, 1899	148
10	St. Louis, Mo.	Oct. 16-18, 1900	143
11	Atlanta, Ga.	Oct. 15-17, 1901	171
12	Minneapolis, Minn.	Oct. 21-23, 1902	195
13	Quebec, Canada	Oct. 20-22, 1903	223
14	Chicago, Ill.	Oct. 18-20, 1904	293
15	Pittsburgh, Pa.	Oct. 17-19, 1905	313
16	Boston, Mass.	Oct. 16-18, 1906	340
17	Milwaukee, Wis.	Oct. 15-17, 1907	341
18	Washington, D. C.	Oct. 20-22, 1908	368
19	Jacksonville, Fla.	Oct. 19-21, 1909	393
20	Denver, Colo.	Oct. 18-20, 1910	428
21	St. Louis, Mo.	Oct. 17-19, 1911	499
22	Baltimore, Md.	Oct. 15-17, 1912	524
23	Montreal, Quebec	Oct. 21-23, 1913	570
24	Los Angeles, Cal.	Oct. 20-22, 1914	586
25	Detroit, Mich.	Oct. 19-21, 1915	665

No.	Place of Meeting	Date	Membership
26	New Orleans, La.	Oct. 17-19, 1916	710
27	Chicago, Ill.	Oct. 16-18, 1917	704
28	Chicago, Ill.	Oct. 15-17, 1918	716
29	Cleveland, Ohio	Oct. 21-23, 1919	776
30	Atlanta, Ga.	Oct. 26-28, 1920	840
31	New York, N.Y.	Oct. 18-20, 1921	850
32	Cincinnati, Ohio	Oct. 17-19, 1922	865
33	Seattle, Wash.	Oct. 16-18, 1923	846
34	Kansas City, Mo.	Oct. 21-23, 1924	837
35	Buffalo, N.Y.	Oct. 20-22, 1925	759
36	Richmond, Va.	Oct. 12-14, 1926	750
37	Minneapolis, Minn.	Oct. 18-20, 1927	754
38	Boston, Mass.	Oct. 23-25, 1928	755
39	New Orleans, La.	Oct. 15-17, 1929	755
40	Louisville, Ky.	Oct. 21-23, 1930	713
41	Chicago, Ill.	Oct. 16-18, 1934	592
42	Chicago, Ill.	Oct. 15-17, 1935	547
43	Chicago, Ill.	Oct. 20-22, 1936	588
44	Chicago, Ill.	Oct. 19-21, 1937	566
45	Chicago, Ill.	Oct. 18-20, 1938	589
46	Chicago, Ill.	Oct. 17-19, 1939	546
47	Chicago, Ill.	Oct. 15-17, 1940	610
48	Chicago, Ill.	Oct. 14-16, 1941	594
49	Chicago, Ill.	Oct. 20-22, 1942	618
50	Chicago, Ill.	Oct. 20-21, 1943	597
51	Chicago, Ill.	Sept. 17-19, 1946	698
52	Chicago, Ill.	Sept. 16-18, 1947	651
53	Chicago, Ill.	Sept. 20-22, 1948	652
54	Chicago, Ill.	Sept. 12-14, 1949	676
55	Chicago, Ill.	Sept. 18-20, 1950	713
56	Chicago, Ill.	Sept. 17-19, 1951	676
57	Chicago, Ill.	Sept. 15-17, 1952	667
58	Chicago, Ill.	Sept. 15-17, 1953	666
59	Chicago, Ill.	Sept. 13-15, 1954	682
60	Chicago, Ill.	Sept. 19-21, 1955	625
61	Chicago, Ill.	Sept. 18-20, 1956	657
62	Chicago, Ill.	Sept. 23-25, 1957	769
63	Chicago, Ill.	Sept. 15-17, 1958	828
64	Chicago, Ill.	Sept. 15-17, 1959	863
65	Chicago, Ill.	Sept. 19-21, 1960	932
66	Chicago, Ill.	Sept. 18-20, 1961	968
67	Chicago, Ill.	Sept. 10-12, 1962	942
68	Chicago, Ill.	Oct. 14-16, 1963	887

PAST OFFICERS

	1891-1892	1892-1893	1893-1894	1894-1895
President	O. J. Travis	H. M. Hall	J. E. Wallace	Geo. W. Andrews
1st V.-Pres.	H. M. Hall	J. E. Wallace	Geo. W. Andrews	W. A. McGonagle
2nd V.-Pres.	J. B. Mitchell	G. W. Hinman	W. A. McGonagle	L. K. Spafford
3rd V.-Pres.	James Stannard	N. W. Thompson	L. K. Spafford	James Stannard
4th V-Pres.	G. W. Hinman	C. T. Fuller	E. D. Hines	Walter G. Berg
Secretary	C. W. Gooch	S. F. Patterson	S. F. Patterson	S. F. Patterson
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Executive Members	W. R. Damon	G. W. Andrews	Q. McNab	James Stannard
	G. W. Markley	J. M. Staten	A. S. Markley	James H. Travis
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	C. W. McGehee	Q. McNab	James Stannard	R. M. Peck
	G. W. Turner	Floyd Ingram	James H. Travis	J. L. White
	J. E. Wallace	A. S. Markley	J. H. Cummin	A. Shane

	1895-1896	1896-1897	1897-1898	1898-1899
President	W. A. McGonagle	James Stannard	Walter G. Berg	J. M. Cummin
1st V.-Pres.	L. K. Spafford	Walter G. Berg	J. H. Cummin	A. S. Markley
2nd V.-Pres.	James Stannard	J. H. Cummin	A. S. Markley	C. C. Mallard
3rd V.-Pres.	Walter G. Berg	A. S. Markley	G. W. Hinman	W. A. Rogers
4th V.-Pres.	J. H. Cummin	R. M. Peck	C. C. Mallard	J. M. Staten
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	George M. Reid	N. W. Thompson	N. W. Thompson	N. W. Thompson
Executive Members	R. M. Peck	W. O. Eggleston	G. J. Bishop	Wm. S. Danes
	J. L. White	W. M. Noon	C. P. Austin	J. H. Markley
	A. Shane	J. M. Staten	M. Riney	W. O. Eggleston
	A. S. Markley	G. J. Bishop	Wm. S. Danes	R. L. Heflin
	W. M. Noon	C. P. Austin	J. H. Markley	F. W. Tanner
	J. M. Staten	M. Riney	W. O. Eggleston	A. Zimmerman

	1899-1900	1900-1901	1901-1902	1902-1903
President	Aaron S. Markley	W. A. Rogers	W. S. Danes	B. F. Pickering
1st V.-Pres.	W. A. Rogers	W. S. Danes	B. F. Pickering	C. C. Mallard
2nd V.-Pres.	J. M. Staten	B. F. Pickering	A. Shane	A. Shane
3rd V.-Pres.	Wm. S. Danes	A. Shane	A. Zimmerman	A. Zimmerman
4th V.-Pres.	B. F. Pickering	A. Zimmerman	C. C. Mallard	A. Montzheimer
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	N. W. Thompson	N. W. Thompson	N. W. Thompson	N. W. Thompson
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	F. W. Tanner	F. W. Tanner	A. W. Merrick	C. P. Austin
	A. Zimmerman	A. Montzheimer	C. P. Austin	C. A. Lichty
	H. D. Cleaveland	W. E. Smith	C. A. Lichty	W. O. Eggleston
	A. Montzheimer	A. W. Merrick	W. O. Eggleston	J. H. Markley

	1903-1904	1904-1905	1905-1906	1906-1907
President	A. Montzheimer	C. A. Lichty	J. B. Sheldon	J. H. Markley
1st V.-Pres.	A. Shane	J. B. Sheldon	J. H. Markley	R. H. Reid
2nd V.-Pres.	C. A. Lichty	J. H. Markley	R. H. Reid	J. P. Canty
3rd V.-Pres.	J. B. Sheldon	R. H. Reid	R. C. Sattley	H. Rettinghouse
4th V.-Pres.	J. H. Markley	R. C. Sattley	J. P. Canty	F. E. Schall
Secretary	S. F. Patterson	S. F. Patterson	S. F. Patterson	S. F. Patterson
Treasurer	C. P. Austin	C. P. Austin	C. P. Austin	C. P. Austin
Executive Members	R. H. Reid	W. O. Eggleston	H. Rettinghouse	W. O. Eggleston
	W. O. Eggleston	A. E. Killam	A. E. Killam	A. E. Killam
	A. E. Killam	H. Rettinghouse	J. S. Lemond	J. S. Lemond
	R. C. Sattley	J. S. Lemond	C. W. Richey	C. W. Richey
	H. Rettinghouse	W. H. Finley	H. H. Eggleston	H. H. Eggleston
	J. S. Lemond	C. W. Richey	F. E. Schall	B. J. Sweatt

	1907-1908	1908-1909	1909-1910	1910-1911
President	R. H. Reid	J. P. Canty	H. Rettinghouse	H. Rettinghouse
1st V.-Pres.	J. P. Canty	H. Rettinghouse	J. S. Lemond	F. E. Schall
2nd V.-Pres.	H. Rettinghouse	F. E. Schall	F. E. Schall	A. E. Killam
3rd V.-Pres.	F. E. Schall	J. S. Lemond	A. E. Killam	J. N. Penwell
4th V.-Pres.	W. O. Eggleston	A. E. Killam	J. N. Penwell	L. D. Hadwen
Secretary	S. F. Patterson	S. F. Patterson	C. A. Lichty	C. A. Lichty
Treasurer	C. P. Austin	C. P. Austin	J. P. Canty	J. P. Canty
Executive Members	A. E. Killam	J. N. Penwell	W. Beahan	T. J. Fullem
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	C. W. Richey	F. B. Scheetz	L. D. Hadwen	P. Swenson
	T. S. Leake	W. H. Finley	T. J. Fullem	G. W. Rear
	W. H. Finley	L. D. Hadwen	G. Aldrich	W. O. Eggleston
	J. N. Penwell	T. J. Fullem	P. Swenson	W. F. Steffens

	1911-1912	1912-1913	1913-1914	1914-1915
President	F. E. Schall	A. E. Killam	J. N. Penwell	L. D. Hadwen
1st V.-Pres.	A. E. Killam	J. N. Penwell	L. D. Hadwen	G. Aldrich
2nd V.-Pres.	J. N. Penwell	L. D. Hadwen	G. Aldrich	G. W. Rear
3rd V.-Pres.	L. D. Hadwen	T. J. Fullem	G. W. Rear	C. E. Smith
4th V.-Pres.	T. J. Fullem	G. Aldrich	C. E. Smith	E. B. Ashby
Secretary	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Treasurer	J. P. Canty	J. P. Canty	J. P. Canty	F. E. Weise
Executive Members	G. Aldrich	G. W. Rear	W. F. Steffens	W. F. Steffens
	P. Swenson	W. F. Steffens	E. B. Ashby	S. C. Tanner
	G. W. Rear	E. B. Ashby	S. C. Tanner	Lee Jutton
	W. F. Steffens	C. E. Smith	Lee Jutton	F. F. Strouse
	E. B. Ashby	S. C. Tanner	W. F. Strouse	C. R. Knowles
	W. O. Eggleston	Lee Jutton	C. R. Knowles	A. Ridgway

	1915-1916	1916-1917	1917-1918	1918-1919
President	G. W. Rear	C. E. Smith	S. C. Tanner	Lee Jutton
1st V.-Pres.	C. E. Smith	E. B. Ashby	Lee Jutton	F. E. Weise
2nd V.-Pres.	E. B. Ashby	S. C. Tanner	F. E. Weise	W. F. Strouse
3rd V.-Pres.	S. C. Tanner	Lee Jutton	W. F. Strouse	C. R. Knowles
4th V.-Pres.	Lee Jutton	F. E. Weise	C. R. Knowles	A. Ridgway
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Executive Members	F. E. Weise	W. F. Strouse	A. Ridgway	J. S. Robinson
	W. F. Strouse	C. R. Knowles	J. S. Robinson	J. P. Wood
	C. R. Knowles	A. Ridgway	J. P. Wood	A. B. McVay
	A. Ridgway	J. S. Robinson	D. C. Zook	J. H. Johnston
	J. S. Robinson	J. P. Wood	A. B. McVay	E. T. Howson
	J. P. Wood	D. C. Zook	J. H. Johnston	C. W. Wright

	1919-1920	1920-1921	1921-1922	1922-1923
President	F. E. Weise	W. F. Strouse	C. R. Knowles	Arthur Ridgway
1st V.-Pres.	W. F. Strouse	C. R. Knowles	A. Ridgway	J. P. Wood
2nd V.-Pres.	C. R. Knowles	A. Ridgway	J. S. Robinson	J. S. Robinson
3rd V.-Pres.	A. Ridgway	J. S. Robinson	J. P. Wood	C. W. Wright
4th V.-Pres.	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.			F. E. Weise	F. E. Weise
Directors	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
	A. B. McVay	A. B. McVay	J. H. Johnston	Maro Johnson
	J. H. Johnston	G. A. Manthey	E. K. Barrett	O. F. Dalstrom
	E. T. Howson	E. T. Howson	F. C. Baluss	S. D. Corey
	C. W. Wright	J. H. Jonhston	Maro Johnson	W. B. Hotson
	G. A. Manthey	E. K. Barrett	O. F. Dalstrom	P. N. Nelson

	1923-1924	1924-1925	1925-1926	1926-1927
President	J. S. Robinson	J. P. Wood	C. W. Wright	E. T. Howson
1st V.-Pres.	J. P. Wood	C. W. Wright	E. T. Howson	F. C. Baluss
2nd V.-Pres.	C. W. Wright	E. T. Howson	F. C. Baluss	Maro Johnson
3rd V.-Pres.	E. T. Howson	F. C. Baluss	Maro Johnson	J. S. Huntoon
4th V.-Pres.	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise	F. E. Weise	F. E. Weise
Directors	S. T. Corey	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
	W. B. Hotson	A. I. Gauthier	W. B. Hotson	E. L. Sinclair
	P. N. Nelson	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom
	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	W. T. Krausch
	A. I. Gauthier	W. B. Hotson	E. L. Sinclair	R. C. Bardwell
	E. L. Sinclair	P. N. Nelson	O. F. Dalstrom	H. I. Benjamin

	1927-1928	1928-1929	1929-1930	1930-1934
President	F. C. Baluss	Maro Johnson	J. S. Huntoon	C. S. Heritage
1st V.-Pres.	Maro Johnson	J. S. Huntoon	C. S. Heritage	A. I. Gauthier
2nd V.-Pres.	J. S. Huntoon	C. S. Heritage	A. I. Gauthier	H. I. Benjamin
3rd V.-Pres.	C. S. Heritage	A. I. Gauthier	H. I. Benjamin	W. T. Krausch
4th V.-Pres.	A. I. Gauthier	H. I. Benjamin	W. T. Krausch	T. H. Strate
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Asst. Sec.	F. E. Weise	F. E. Weise		
Directors	W. T. Krausch	R. C. Henderson	G. A. Rodman	E. C. Neville
	R. C. Bardwell	J. S. Ekey	W. A. Batey	H. H. Best
	H. I. Benjamin	T. H. Strate	F. W. Hillman	J. E. King
	R. C. Henderson	G. A. Rodman	E. C. Neville	A. B. Scowden
	T. H. Strate	W. A. Batey	H. H. Best	W. A. Batey
	J. S. Ekey	F. W. Hillman	J. E. King	L. C. Smith

	1934-1935	1935-1936	1936-1937	1937-1938
President	H. I. Benjamin	T. H. Strate	E. C. Neville	C. M. Burpee
1st V.-Pres.	T. H. Strate	E. C. Neville	C. M. Burpee	F. H. Masters
2nd V.-Pres.	E. C. Neville	C. M. Burpee	F. H. Masters	W. S. Lacher
3rd V.-Pres.	A. B. Scowden	F. H. Masters	C. A. J. Richards	C. A. J. Richards
4th V.-Pres.	W. R. Roof	C. A. J. Richards	W. S. Lacher	F. H. Cramer
Sec.-Treas.	C. A. Lichty	C. A. Lichty	C. A. Lichty	C. A. Lichty
Directors	C. M. Burpee	A. L. McCloy	W. R. Roof	B. R. Meyers
	W. A. Batey	R. P. Luck	T. P. Soule	G. S. Crites
	L. C. Smith	H. H. Best	F. H. Cramer	R. E. Dove
	C. A. J. Richards	W. R. Roof	B. R. Meyers	T. P. Soule
	A. L. McCoy	T. P. Soule	G. S. Crites	A. Chinn
	R. P. Luck	F. H. Cramer	R. E. Dove	L. G. Byrd

	1938-1939	1939-1940	1940-1941	1941-1942
President	Armstrong Chinn	A. E. Bechtelheimer	H. M. Church	R. E. Dove
1st V.-Pres.	F. H. Cramer	F. H. Cramer	R. E. Dove	F. H. Soothill
2nd V.-Pres.	A. E. Bechtelheimer	H. M. Church	F. A. Soothill	G. S. Crites
3rd V.-Pres.	H. M. Church	R. E. Dove	G. S. Crites	A. M. Knowles
4th V.-Pres.	R. E. Dove	F. H. Soothill	A. M. Knowles	N. D. Howard
Sec.-Treas.	C. A. Lichty	C. A. Lichty		
Secretary	.....	.....	F. O. Whiteman	A. G. Shaver
Treasurer	.....	.....	F. E. Weise	F. E. Weise
Directors	L. G. Byrd	B. R. Meyers	N. D. Howard	R. E. Caudle
	W. R. Ganser	W. Walkden	L. G. Byrd	I. A. Moore
	F. H. Soothill	A. S. Krefting	K. L. Miner	W. A. Sweet
	B. R. Meyers	A. M. Knowles	R. E. Caudle	J. L. Varker
	W. Walkden	L. G. Byrd	I. A. Moore	L. E. Peyser
	A. S. Krefting	K. L. Miner	W. A. Sweet	Martin Meyer

	1942-1943	1943-1944	1944-1945	1945-1946
President	G. S. Crites	J. L. Varker	J. L. Varker	N. D. Howard
1st V.-Pres.	R. E. Caudle	R. E. Caudle	R. E. Caudle	F. G. Campbell
2nd V.-Pres.	A. M. Knowles	N. D. Howard	N. D. Howard	J. S. Hancock
3rd V.-Pres.	N. D. Howard	F. G. Campbell	F. G. Campbell	E. H. Barnhart
4th V.-Pres.	J. L. Varker	J. S. Hancock	J. S. Hancock	W. F. Martens
Secretary	A. G. Shaver† Lorene Kindred‡ Elinor V. Heffern	Elinor V. Heffern	Elise LaChance	Elise LaChance
Treasurer	F. E. Weise	C. R. Knowles	C. R. Knowles	C. R. Knowles
Treasurer Emeritus		F. E. Weise	F. E. Weise	
Directors	M. Meyer	W. F. Martens	W. F. Martens	A. B. Chapman
	L. E. Peyser	A. L. McCloy	A. L. McCloy	W. A. Huckstep
	K. L. Miner	L. C. Winkelhaus	L. C. Winkelhaus	F. R. Spofford
	F. G. Campbell	E. H. Barnhart	E. H. Barnhart	Guy E. Martin
	J. S. Hancock	A. B. Chapman	A. B. Chapman	B. R. Meyers
	L. C. Winkelhaus	L. E. Peyser	L. E. Peyser	L. E. Peyser

†To November 1, 1942
‡To February 1, 1943

	1946-1947	1947-1948	1948-1949	1949-1950
President	F. G. Campbell	J. S. Hancock	E. H. Barnhart	W. F. Martens
1st V.-Pres.	J. S. Hancock	E. H. Barnhart	W. F. Martens	W. A. Huckstep
2nd V.-Pres.	E. H. Barnhart	W. F. Martens	W. A. Huckstep	Guy E. Martin
3rd V.-Pres.	W. F. Martens	W. A. Huckstep	Guy E. Martin	F. R. Spofford
4th V.-Pres.	W. A. Huckstep	G. E. Martin	F. R. Spofford	Lee Mayfield
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	C. R. Knowles	C. R. Knowles	L. C. Winkelhaus	L. C. Winkelhaus
Directors	Guy E. Martin	H. M. Harlow	Lee Mayfield	H. M. Harlow
	B. R. Meyers	H. B. Christianson	F. M. Misch	V. E. Engman
	L. E. Peyser	F. R. Spofford	W. D. Gibson	G. W. Benson
	H. M. Harlow	Lee Mayfield	H. M. Harlow	F. M. Misch
	H. B. Christianson	Franz M. Misch	V. E. Engman	L. R. Morgan
	F. R. Spofford	W. D. Gibson	G. W. Benson	J. A. Jorlett

	1950-1951	1951-1952	1952-1953	1953-1954
President	W. A. Huckstep	Guy E. Martin	F. R. Spofford	Lee Mayfield
1st V.-Pres.	Guy E. Martin	F. R. Spofford	Lee Mayfield	H. M. Harlow
2nd V.-Pres.	F. R. Spofford	Lee Mayfield	H. M. Harlow	J. A. Jorlett
3rd V.-Pres.	Lee Mayfield	H. M. Harlow	J. A. Jorlett	R. R. Gunderson
4th V.-Pres.	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	F. M. Misch	M. H. Dick	W. H. Huffman	M. H. Dick
	L. R. Morgan	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells
	J. A. Jorlett	J. F. Warrenfells	B. M. Stephens	G. Switzer
	M. H. Dick	W. H. Huffman	M. H. Dick	B. M. Stephens
	R. R. Gunderson	L. R. Morgan	J. F. Warrenfells	W. H. Bunge
	J. F. Warrenfells	B. M. Stephens	G. Switzer	E. R. Schlaf

	1954-1955	1955-1956	1956-1957	1957-1958
President	H. M. Harlow	J. A. Jorlett	R. R. Gunderson	W. H. Huffman
1st V.-Pres.	J. A. Jorlett	R. R. Gunderson	W. H. Huffman	M. H. Dick
2nd V.-Pres.	R. R. Gunderson	W. H. Huffman	M. H. Dick	B. M. Stephens
3rd V.-Pres.	W. H. Huffman	M. H. Dick	B. M. Stephens	H. D. Curie
4th V.-Pres.	M. H. Dick	B. M. Stephens	H. D. Curie	
Secretary	Elise LaChance	Elise LaChance	Elise LaChance	Elise LaChance
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	B. M. Stephens	J. F. Warrenfells	W. H. Bunge	G. W. Benson
	W. H. Bunge	H. D. Curie	E. R. Schlaf	J. M. Lowry
	E. R. Schlaf	J. M. Lowry	G. W. Benson	H. A. Matthews
	J. F. Warrenfells	W. H. Bunge	J. M. Lowry	T. M. von Sprecken
	H. D. Curie	E. R. Schlaf	T. M. von Sprecken	W. H. Bunge
	J. M. Lowry	G. W. Benson	H. A. Matthews	E. R. Schlaf

	1958-1959	1959-1960	1960-1961	1961-1962
President	M. H. Dick	B. M. Stephens	H. D. Curie	G. W. Benson
1st V.-Pres.	B. M. Stephens	H. D. Curie	G. W. Benson	J. M. Lowry
2nd V.-Pres.	H. D. Curie	G. W. Benson	J. M. Lowry	E. R. Schlaf
3rd V.-Pres.	G. W. Benson	J. M. Lowry	E. R. Schlaf	H. A. Matthews
Secretary	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg	Ruth Weggeberg
Treasurer	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus	L. C. Winkelhaus
Directors	J. M. Lowry	W. H. Bunge	H. A. Matthews	R. C. Baker
	R. C. Baker	E. R. Schlaf	M. J. Hubbard	R. H. Miller
	W. H. Bunge	H. A. Matthews	R. C. Baker	Shirley White
	E. R. Schlaf	M. J. Hubbard	R. H. Miller	H. M. Wilson
	H. A. Matthews	R. C. Baker	Shirley White	R. D. Hellweg
	M. J. Hubbard	R. H. Miller	H. M. Wilson	F. W. Hutcheson

	1962-1963			
President	J. M. Lowry			
1st V.-Pres.	E. R. Schlaf			
2nd V.-Pres.	H. A. Matthews			
3rd V.-Pres.	R. C. Baker			
Secretary	Ruth Weggeberg			
Treasurer	L. C. Winkelhaus			
Directors	Shirley White			
	H. M. Wilson			
	R. D. Hellweg			
	F. W. Hutcheson			
	W. F. Armstrong			
	J. W. DeValle			

CONSTITUTION

ARTICLE I.

NAME

Section 1. This association shall be known as the American Railway Bridge & Building Association.

ARTICLE II.

OBJECT

Section 1.** The object of this association shall be the advancement of knowledge pertaining to the design, construction and maintenance of railway bridges, buildings, water service facilities, and other structures, by investigation, reports and discussions.

Section 2. The association shall neither indorse nor recommend any particular devices, trade marks or materials, nor will it be responsible for any opinions expressed in papers, reports or discussions unless the same have received the endorsement of the association in regular session.

ARTICLE III.

MEMBERSHIP

Section 1. The membership of this association shall be divided into five classes, viz: Members, life members, associate, honorary and junior members.*

Section 2.** A member shall be a person in a position above rank of gang foreman in connection with roadway bridge, building and water service work, or in the employ of a public regulatory body, a professor of engineering in a college, an engineering editor, or a government or private timber expert. Any person desirous of becoming a member shall make application upon the form prescribed by the executive committee, setting forth his name, age, residence and practical experience. He shall furnish at least three references to whom he is personally known. Applicants may be voted into membership at any regular executive meeting or by letter ballot of the executive committee, a majority vote being necessary in either instance.

Section 3.** To be eligible for a life membership a member must have belonged to the association for at least 15†† years and in general must have retired from active railway service due to age or physical disability. He shall have all the privileges of active membership, except the holding of office, and shall not be required to pay annual dues. The transfer from membership to life membership shall be made in the same manner as the election of members, as prescribed in Section 2, of this Article.

Section 4. Associates shall be responsible persons who are not eligible as members, whose pursuits or attainments qualify them to co-operate with members in the study and development of improved practices in the construction and maintenance of bridges, buildings and water facilities. They shall have all the rights of members except of voting and holding office. They shall be elected in the manner prescribed for members, in Section 2, of this Article.

Section 5. Honorary members shall be chosen from persons who have attained acknowledged eminence in some branch of engineering or railway service. Their number shall be limited to ten. Honorary members shall be proposed by not less than six active members and shall be elected by the unanimous vote of the members

*Amended October 16, 1941.
**Amended September 20, 1948.
††Amended March 10, 1958.

present at a regular meeting. They shall have all the rights of active members except that of holding office and shall be exempt from the payment of dues.

Section 6. A junior member shall be a person who is a graduate of a recognized engineering school, or who has been employed for at least two years in the design, maintenance or construction of railway bridges, buildings or structures. Applicants shall be at least 21 years of age and they shall be elected in the manner prescribed for members, in Section 2 of this article. Juniors shall have all the rights of members except that of holding office. When the attainments of a Junior are such as to qualify him as a member, he may apply for promotion and the Executive Committee shall authorize such promotion when qualifications warrant the action. Unless a Junior is promoted, his membership shall cease automatically when he becomes 28 years of age.*

Section 7. Any member guilty of conduct unbecoming to a railroad officer and a member of this association, or who shall refuse to comply with the rules of this association, shall forfeit his membership on a two-thirds vote of the executive committee.

Section 8. Membership shall continue until written resignation is received by the secretary, unless member has been previously expelled, or dropped for non-payment of dues in accordance with Section 1 of Article VII.

Section 9.** Only active members shall hold office in this association, and only active and life members shall be entitled to vote in the election of officers.

ARTICLE IV.

OFFICERS

Section 1†. The officers of this association shall be a president, three vice-presidents, a secretary, a treasurer and six directors who with the most recent past president shall constitute the executive committee.

Section 2. The past presidents of this association, previous to the most recent past president, who continue to be members, shall be privileged to attend all meetings of the executive committee, of which meetings they shall receive due notice, and be permitted to discuss all questions and to aid said committee by their advice and counsel; but said past presidents shall not have a right to vote, unless called upon to fill a quorum.

Section 3. Vacancies in any office shall be filled for the unexpired term by the executive committee without delay.

ARTICLE V.

EXECUTIVE COMMITTEE

Section 1.** The executive committee shall manage the affairs of the association and shall have full power to control and regulate all matters not otherwise provided for in the constitution and by-laws and shall exercise general supervision over the financial interests of the association, and make all necessary purchases and contracts required to conduct the general business of the association, but shall not have the power to render the association liable for any debt beyond the amount then in the treasury plus accounts receivable and not subject to other prior liabilities. All appropriations for special purposes must be acted upon at a regular meeting of the association.

Section 2. Meetings of the executive committee may be called by a majority of the members of the committee, providing 10 days' notice is given members by mail.

Section 3. Five members of the executive committee shall constitute a quorum for the transaction of business.

ARTICLE VI.

ELECTION OF OFFICERS AND TENURE OF OFFICE

Section 1. Except as otherwise provided, the officers shall be elected at the regular annual meeting of the association and the election shall not be postponed except by unanimous consent of the members present at said annual meeting. The

*Amended October 16, 1941.
**Amended September 20, 1948.
†Amended September 21, 1957.

election shall be by ballot, a majority of the votes cast being required for election. Any active member of the association not in arrears for dues shall be eligible for office, but the president shall not be eligible for reëlection.

Section 2‡. The president, three vice-presidents, secretary and treasurer shall hold office for one year and the directors for three years, two directors being elected each year. All officers retain their office until their successors are elected and installed. A director elected for a three-year term shall not be eligible to serve two consecutive terms.

Section 3.† The term of office of the secretary and the treasurer may be terminated at any time by a two-thirds vote of the executive committee. Their compensation shall be fixed by a majority vote of the executive committee.

The secretary shall also serve as secretary of the executive committee.

Section 4. The secretary and the treasurer shall be required to give bond in an amount to be fixed by the executive committee.

ARTICLE VII.

MEMBERSHIP FEE AND DUES

Section 1.† Every member upon joining this association shall pay to the secretary an entrance fee and dues as prescribed by the executive committee. No member in arrears for annual dues shall be entitled to vote at any election and any member more than one year in arrears may be stricken from the list of members at the discretion of the executive committee.

Section 2.‡ A person stricken from the list of members because of non-payment of dues, upon written application may be reinstated as a member in his former class without loss of privileges, either upon payment of all back dues (which must accompany application) or at the discretion of the Executive Committee voting in the manner prescribed in Section 2, Article III.

ARTICLE VIII.*

LOCAL SECTIONS

Section 1.** Upon the application of ten or more members of the association residing in the same geographical district, or having offices therein, the executive committee shall organize a local section for that district, to which all members in that district shall be eligible. Such local section shall admit to active membership only members in good standing. It shall hold not less than two meetings each year, and shall be governed by such constitution and by-laws not inconsistent with the constitution of this association as the section membership may adopt and the executive committee of the association approve.

Section 2. The parent association shall not be put under any obligation, either financial or in the matter of policy or opinion, by any local section.

ARTICLE IX.

AMENDMENTS

Section 1. This constitution may be amended at any regular meeting by a two-thirds vote of the members present, provided that notice of the proposed amendment or amendments has been sent to the members at least 30 days previous to said regular meeting.

BY-LAWS

TIME OF MEETING

1.** The regular meeting of this association shall convene annually during the month of September, the exact date to be fixed by the Executive Committee.

PLACE OF MEETING

2.** The place of holding the annual convention shall be Chicago, Ill.

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†Amended October 17, 1940.
*Article adopted 1922.
**Amended September 20, 1948.
‡Amended September 21, 1957.

3. It shall lie within the power of the executive committee to change the location or time of the meeting if it becomes apparent that it is for the best interests of the association.

QUORUM

4. At the regular meeting of the association, 15 or more members shall constitute a quorum.

**DUES

5. The annual dues, for the fiscal year ending August 31, and payable in advance, shall be as follows:*

Members, $5.00; Associate Members, $4.00; Junior Members, $2.50.

DUTIES OF OFFICERS

6.† The president shall have general supervision over the affairs of the association. He shall preside at all meetings of the association and of the executive committee; shall appoint all committees not otherwise provided for, and shall be ex-officio member of all committees. He shall with the secretary sign all contracts or other written obligations of the association which have been approved by the executive committee. He shall render a detailed report at least three times during the year to the members of the executive committee, showing the financial condition of the association and its activities.

At the annual meeting the president shall present a report containing a statement of the general conditions of the association.

7. The vice-presidents in order of seniority shall preside at meetings in the absence of the president and discharge his duties in case of a vacancy in his office.

8.† It shall be the duty of the secretary to keep a correct record of the proceedings of all meetings of this association, and of all accounts, between this association and its members; to collect all moneys due the association, and deposit the same in the name of the association. He shall pay all bills when properly certified and approved by the president and the treasurer, and make such reports as may be called for by the executive committee. He shall also perform such other duties as the association may require.

9.‡ The treasurer shall have charge of the funds, check all deposits as made by the secretary, sign all checks after they have been approved by the president, and invest all funds not needed for current expenses as directed by the executive committee. He shall report at each annual meeting on the condition of the finances.

NOMINATING COMMITTEE

10.# After each annual meeting the president shall appoint a committee consisting of five members. Two Past Presidents shall be members of this committee, one of whom shall act as Chairman. No other officers of the Association shall be appointed to this committee. This committee shall prepare a list of names of nominees for officers to be voted on at the next annual convention in accordance with ARTICLE VI of the Constitution, said list to be read at the business session of said convention. Nothing in this section shall be construed to prevent any member making further nominations.

AUDITING COMMITTEE

11.‡ Prior to each annual meeting the president shall appoint a committee of three members, not officers of the association, whose duty it shall be to examine the accounts and vouchers of the secretary and the treasurer and certify as to the correctness of their accounts.

COMMITTEE ON SUBJECTS FOR DISCUSSION

12. After each annual meeting the president shall appoint a committee whose duty it shall be to prepare a list of subjects for investigation to be submitted for approval at the next convention.

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†Amended October 17, 1940.
‡Adopted October 17, 1940.
*Amended October 16, 1941.
**Amended September 20, 1948.
#Amended December 4, 1950.

COMMITTEE ON INVESTIGATION

13. After the association has adopted the list of subjects for investigation the president for the succeeding year shall appoint the committees who shall prepare the subjects for report and discussion. He may also appoint individual members to prepare reports on special subjects, or to report on any special or particular subject.

PUBLICATION COMMITTEE

14. After each annual meeting the executive committee shall appoint a publication committee consisting of three active members whose duty it shall be to coöperate with the secretary in the issuing of the publications of the association. The assignment of this committee shall be such that at least one member shall have served on the committee during the previous year.

ORDER OF BUSINESS

15.† Call to order by president.
Opening prayer or invocation.
President's address.
Report of secretary.
Report of treasurer.
Appointment of special committees.
Reports of standing committees and presentation of papers.
Unfinished business.
New business.
Election of officers.
Installation of officers.
Adjournment.

DECISIONS

16. The votes of a majority of the members present shall decide any questions, motion or resolution which shall be brought before the association, unless otherwise provided. Unless specifically provided herein otherwise, all discussions shall be governed by Robert's rules of order.

AMENDMENTS

17.† The By-Laws can be amended by a two-thirds vote of those present at any regularly called Executive Committee Meeting.

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†Amended September 20, 1948.

DIRECTORY OF MEMBERS

as of January 15, 1964

(Figure after each name indicates year when member joined the Association)

* Indicates Junior Member

HONORARY MEMBERS

Barnhart, E. H., (Ret.) Div. Engr., B. & O., St. Petersburg, Fla. (1941)
Howard, N. D., Exec. Secy., A. R. E. A., Chicago, Ill. (1926)
Strate, T. H., (Ret.) Div. Engr., C. M. St. P. & P., San Ysidro, Calif. (1918)
Vandenburgh, E. C., (Ret.) Ch. Engr., C. & N. W., Chicago, Ill. (1925)
Winkelhaus, L. C., (Ret.) Arch. Engr., C. & N. W., Chicago, Ill. (1934)

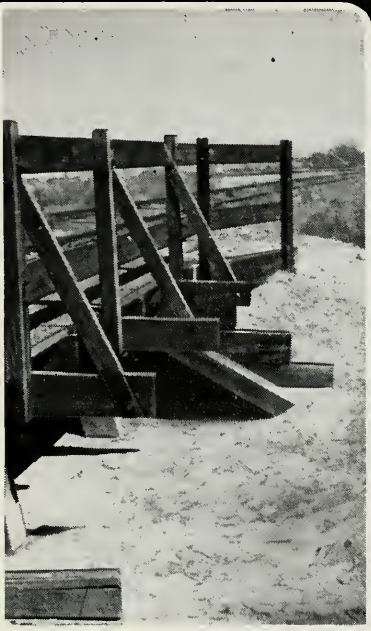
ACTIVE MEMBERS

A

Adams, J. H., Jr., Bldg. Engr.-Sys., C. & O., Huntington, W. Va. (1961)
Albert. E. A., Supvr. B. & B., I. C., Champaign, Ill. (1956)
Alderson, A. D., Asst. Ch. Engr. Br. & Struct., S. L., Minneapolis, Minn. (1961)
Alexander, M. B., Supvr. Struct., B. & L. E., Greenville, Pa. (1961)
Allen, J. P., Engr. Brdgs., Sou., Knoxville, Tenn. (1963)
Allen, W. V., Supvr. B. & B., C. & O., Huntington, W. Va. (1959)
Alley, F. T., Asst. B. & B. Supv., St. L. S. W., Tyler, Tex. (1955)
Anderson, A. C., Gen. B. & B. Fore., D. M. & I. R., Two Harbors, Minn. (1952)
Anderson, M. P., Ch. Engr., Monon, Lafayette, Ind. (1959)
Anthony, O. D., Civil Engr., B. & A., Houlton, Me. (1962)
Armstrong, W. F., Engr. Bldgs., C. & N. W., Chicago, Ill. (1947)
Arnold, L. K., Asst. Gen. Fore. B. & B.-W. S., A. T. & S. F., San Bernardino, Calif. (1963)
Arrington, R., Jr. Struc. Design., S. P., Houston, Texas (1963)
Austin, S. B., Ch. Engr., G. & F., Augusta, Ga. (1963)

B

Babcock, D. L., Supv. B. & B., C. & N. W., Milwaukee, Wis. (1953)
Bach, S. A., B. & B. Supvr., M. P., Monroe, La. (1962)
Baker, F. A., Asst. Gen. Br. Insp., S. P., San Francisco, Calif. (1955)
Baker, R. C., Asst. Ch. Engr., C. & E. I., Chicago Heights, Ill. (1940)
Baldock, R. M., Weld. Engr., N. & W., Roanoke, Va. (1961)
Bangs, E. L., Gen. Br. Insp., C. & N. W., Chicago, Ill. (1957)
Barke, W. B., Asst. Supv. B. & B., G. N., Wenatchee, Wash. (1958)
Barnes, J. A., Engr. Trk., C. & N. W., Chicago, Ill. (1957)
Barranco, S. J., Supv. Struc., P. R. R., Cincinnati, Ohio (1951)
Barsema, M., Asst. B. & B. Supv., C. & N. W., Chicago, Ill. (1958)
Bateman, E. F., B. & B. Supv., U. P., Salt Lake City, Utah (1958)
Baymiller, R. R., Div. Engr., S. P., Dunsmuir, Calif. (1961)
Beam, Y. C., Mast. Carp., S. A. L., Americus, Ga. (1945)
Beatty, A. G., Supv. Scl. & Wk. Equip., C. & N. W., Chicago, Ill. (1957)
Beaver, J. F., Ch. Engr., Sou., Washington, D. C. (1950)
Beeder, R. H., Ch. Engr.-Sys., A. T. & S. F., Chicago, Ill. (1958)
Bell, D. V., Mast. Carp., B. & O., Dayton, Ohio (1957)
Bennett, R. S., Asst. Engr. Brdgs., S. P., San Francisco, Calif. (1961)
Benson, G. W., Div. Engr., C. of G., Macon, Ga. (1940)
Benson, O. C., Asst. Engr. M. of W., B. & M., Boston, Mass. (1952)
Beringer, M. A., Supt. Br. Erec., I. C., Chicago, Ill. (1929)
Berman, N., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1961)
Bertel, D. J., Asst. Dist. Engr., M. P., Osawatomie, Kans. (1957)
Billingsley, C. C., Asst. Mast. Carp., S. A. L., Raleigh, N. C. (1959)
Billmeyer, E. D., Br. & Struc. Engr., W. M., Baltimore, Md. (1955)



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3456 PETERSON AVE., CHICAGO 45, ILL.

U.S. BORAX®

Bisbee, R. D., Div. Engr., P. & S. F., Slaton, Tex. (1947)
Bishop, I. A., Mast. Carp., S. A. L., Raleigh, N. C. (1955)
Black, A. R., Sp. Rep., S. P., Houston, Texas (1953)
Blackmore, J., Sr. Asst. B. & B. Supv., S. P., San Jose, Calif. (1960)
Blake, B. D., Res. Engr., C. R. I. & P., El Reno, Okla. (1959)
Blake, J. E., Jr., Supv. Struc., P. R. R., Williamsport, Pa. (1953)
Blanchard, L. C., Rdm., C. M. St. P. & P., Minneapolis, Minn. (1962)
Bleul, G. J., Engr. Bldgs., B. & O., Baltimore, Md. (1959)
Bober, H., B. & B. Engr., G. M. & O., Mobile, Ala. (1947)
Bodell, R. W., Brdg. Insp., C. R. R. of N. J., and N. Y. & L. B., Jersey City, N. J. (1961)
Bodie, B. V., Vice Pres. & Gen. Mgr., G. M. & O., Mobile, Ala. (1951)
Boehling, H. A., Jr., Asst. Supvr. Brdg. Erec.-Sys., C. & O., Richmond, Va. (1948)
Boeser, G. F., Asst. Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1962)
Boling, E. C., Supv. B. & B., N. S., Raleigh, N. C. (1950)
Bolte, W. R., Motor Car Shop Fore., K. C. S., Pittsburg, Kans. (1959)
Booth, H. E., B. & B. Mast., C. N. R., Saskatoon, Sask., Canada (1957)
Born, J. O., Prin. Asst. Engr., M. C., Portland, Me. (1956)
Bost, M. R., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1959)
Bowman, H. A., Mast. Carp., F. W. & D., Wichita Falls, Tex. (1953)
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Kelly, J. R., B. & B. Supv., Sou., Somerset. Ky. (1952)
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Kenyon, J. R., Gen. B. & B. Supv., N. Y. N. H. & H., New Haven, Conn. (1955)
Kick, C. W., Asst. B. & B. Supv., N. P., Seattle, Wash. (1960)
Kieckers, E. W., Brdg. Engr., M. P., St. Louis, Mo. (1958)
Kilby, J. T., B. & B. Mast., C. N., Edmundston, N. B., Can. (1959)
Kinney, T. R., Engr. Struct., C. & E. I., Chicago Heights, Ill. (1961)
Kirkman, T. C., Civil & Ind. Engr., H. P. T. & D., High Point, N. C. (1961)
Klein, C. A., Br. Maint. Engr., Reading, Philadelphia, Pa. (1958)
Klempnauer, E. C., B. & B. Gen. Fore., K. C. T., Kansas City, Mo. (1960)
Klouda, R. G., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1956)
Koehler, P. L., Div. Supt., C. & O., Covington, Ky. (1938)
Koenig, M. E., Div. Engr., C. & N. W., St. Paul, Minn. (1957)
Krefting, A. S., Ch. Engr., S. L., Minneapolis, Minn. (1935)
Kruse, H. H., Asst. Supvr. Brdg. Maint., C. M. St. P. & P., Chicago, Ill. (1957)
Kubacki, L. R., Area Engr. Struct., P. R. R., Chicago, Ill. (1961)
Kubly, I. J., B. & B. Supv., I. C., Chicago, Ill. (1960)

L

LaBeau, J. A., Jr. Designer, E. J. & E., Joliet, Ill. (1963)
La Chapelle, H. A., Ch. Engr., G. B. & W., Green Bay, Wis. (1961)
Lackey, J. B., B. & B. Supv., L. & N., Louisville, Ky. (1958)
Landers, T. W., Off. Engr., Q. N. S. & L., Sept Iles, Que., Canada (1961)
Langmeyer, A. F., Arch., I. C., Chicago, Ill. (1960)
Langston, J. H., Rdm., St. L.-S. F., Pensacola, Fla. (1959)
Larson, K., Supv. B. & B., C. & N. W., Boone, Iowa (1957)
Laurick, M. J., Supvr. Struct., P. R. R., Columbus, Ohio (1952)
Layman, D. C., Supv. B. & B., I. C., Paducah, Ky. (1952)
Lea, E. T., Ch. Engr. M. of W. & Struc., C. & G., Columbus, Miss. (1959)
Leach, A. L., Asst. Engr. Br., I. C., Chicago, Ill. (1955)
LeDonne, J. A., Engr. Trk., Monon. Conn., Pittsburgh, Pa. (1958)
Ledyard, W., Div. Engr., N. Y. C., New York, N. Y. (1962)
Lee, R. W., B. & B. Supvr., Sou., Sheffield, Ala. (1961)
Lehman, J. F., Gen. Fore., P. R. R., Chicago, Ill. (1960)
Leinweber, F. J., B. & B. Mast., C. N. R., London, Ont., Canada (1947)
Lenco, W., Asst. Ch. Engr., C. N. R., Moncton, N. B., Canada (1961)
Lenten, C. F., Incorp., C. & L. C., Lansing, Mich. (1963)
Lichtenberger, F. W., Mast. Carp., E.-L., Marion, Ohio (1959)
Lieser, H. J., Supv. B. & B., C. & W. I., Chicago, Ill. (1948)
Lingle, T. N., Supv. B. & B., I. C., Carbondale, Ill. (1951)
Linn, G. A., Div. Engr., C. & N. W., Chadron, Nebr. (1940)
Little, H. C., Supv. W. S., I. C., New Orleans, La. (1948)
Littlefield, R. I., Asst. B. & B. Supv., S. P., Oakland, Calif. (1960)
Loggins, L. A., Ch. Engr., T. & L. Lines, S. P. Houston, Tex. (1959)
Lokotzke, G. P., Supv. B. & B., E. J. & E., Gary, Ind. (1947)
Long, W. R., Asst. B. & B. Supvr., S. P., Albany, Ore. (1963)

Lowry, J. M., Ch. Engr., St. L. S. W., Tyler, Tex. (1950)
Lucas, H. F., Asst. Engr., C. M. St. P. & P., Chicago, Ill. (1952)
Luce, W. L., Mast. Carp., E.-L., Youngstown, Ohio (1952)
Lund, C. V., Asst. to Ch. Engr., C. M. St. P. & P., Chicago, Ill. (1947)
Lundgren, H. M., B. & B. Mast., C. N. R., Winnipeg, Man., Canada (1957)
Lynch, J. F., Asst. Div. Engr., S. P., Los Angeles, Calif. (1959)
Lyon, L. E., Prin. Asst. Div. Engr., S. P., Walnut Creek, Calif. (1947)

Mc

McCall, R. G., Asst. B. & B. Supvr., D. & R. G. W., Salt Lake City, Utah (1963)
McCauley, M. L., Dist. Engr. Struc., N. Y. C., Syracuse, N. Y. (1950)
*McCluskey, G., Jr. Designer, I. C., Chicago, Ill. (1961)
McCormick, K. L., B. & B. Supv., Pac. Elec., Los Angeles, Calif. (1958)
McCosky, L. E., Supv. B. & B., C. & N. W., Eau Claire, Wis. (1958)
McDermott, B. F., Div. Engr., C. & N. W., Norfolk, Nebr. (1960)
McDiarmid, R. J., Supv. B. & B., E. J. & E., Joliet, Ill. (1957)
McGee, F. E., Ch. Draftsman, P. R. R., Chicago, Ill. (1960)
McGrew, B. H., Supv. B. & B., St. L. S. W., Tyler, Tex. (1951)
McGrew, F. O., Ch. Carp., C. M. St. P. & P., Minneapolis, Minn. (1948)
*McGuffee, R. C., Jr., Jr. Engr.-Grade B., St. L.-S. F., Huntsville, Ala. (1961)
McHaffie, J. N., Asst. Supvr. B. & B., G. N., Minneapolis, Minn. (1962)
McKanna, A. D., Gen. Fore., A. T. & S. F., Newton, Kans. (1962)
McKenney, C. E., Sys. Scl. Insp., N. Y. C. & St. L., Ft. Wayne, Ind. (1956)
McKerley, J. B., Ch. Engr., C. of G., Savannah, Ga. (1961)
McKibben, D. H., Supv. Struc., P. R. R., Harrisburg, Pa. (1951)
McMann, J. B., Gen. B. & B. Fore., U. P., Omaha, Nebr. (1958)
McMaster, R. C., Supvr. Struc., B. & L. E., Butler, Pa. (1960)
McNally, G. S., Designer, I. C., Chicago, Ill. (1963)

M

MacDonald, H. R., Asst. B. & B. Mast., C. N. R., Portage La Prairie, Man., Canada (1963)
Mack, H. L., Asst. Engr., M. P., Houston, Tex. (1959)
MacQuarrie, A. C., B. & B. Mast., C. N., New Glasgow, N. S., Can. (1957)
Madden, E., Supt. B. & B., T. & P., Ft. Worth, Texas (1963)
Madvig, H. F., Asst. Engr., C. M. St. P. & P., Minneapolis, Minn. (1959)
Malmberg, C. R., Supv. B. & B., C. & N. W., Escanaba, Mich. (1957)
Mandia, L., Asst. Supv. Bldgs., P. R. R., New York, N. Y. (1960)
Manson, A., Div. Engr., L. & N., Birmingham, Ala. (1957)
Marks, C. K., Brdg. Engr., C. G. W., Oelwein, Iowa (1963)
Marriott, L. S., Asst. to Engr. Bldgs., I. C., Chicago, Ill. (1960)
*Marshall, M., Designer, I. C., Chicago, Ill. (1960)
Martin, J. D., Ch. Carp., C. M. St. P. & P., Canton, S. D. (1955)
Martin, J. W., Mast. Carp., S. A. L., Tampa, Fla. (1953)
Martin, R. T., Supvr. B. & B., F. E. C., Miami, Fla. (1960)
Martyn, G. W., Off. Engr., E. J. & E., Joliet, Ill. (1959)
Mason, E. L., B. & B. Supvr., M. P., Corpus Christi, Texas (1946)
Mason, S. K., Ch. Engr., T. M., Laredo, Tex. (1950)
Mathias, H. O., Asst. Engr., P. R. R., Chicago, Ill. (1959)
Mathieu, J. L., Draftsman, I. C., Chicago, Ill. (1963)
Matney, E. A., Asst. to Engr. Brdgs., C. R. I. & P., Chicago, Ill. (1963)
*Matt, G. L., Designer, I. C., Chicago, Ill. (1960)
Matthews, H. A., Gen. Fore. B. & B.-W. S., St. L. - S. F., Amory, Miss. (1949)
Matthews, W. L., Sr. Asst. B. & B. Supv., S. P., Tucson, Ariz. (1953)
*Matusik, W., Jr. Designer, I. C., Chicago, Ill. (1961)
May, C. B., Asst. Engr., St. L.-S. F., Amory, Miss. (1962)
Mays, J. W. N., Asst. Engr.-Sys., P. R. R., Philadelphia, Pa. (1947)
Meeker, G. W., Gen. B. & B. Fore., N. Y. N. H. & H., Hartford, Conn. (1959)
Melton, H. W., B. & B. Supv., G. N., Seattle, Wash. (1957)
Meredith, W. E., Supv. Struc., P. R. R., Canton, Ohio (1950)
Merrill, B. W., Supv. B. & B., N. Y. C. & St. L., Conneaut, Ohio (1936)
Meserve, E. S., Supvr. B. & B., B. & M., Dover, N. H. (1949)
Messman, D. V., Asst. to Ch. Engr., Sou., Washington, D. C. (1955)
Mettlach, P. A., B. & B. Fore., G. B. & W., Arcadia, Wis. (1956)
Meyers, B. R., Vice Pres. & Ch. Engr., C. & N. W., Chicago, Ill. (1930)
Michaud, M., Ch. Engr., Q. N. S. & L., Sept Iles, Que., Canada (1961)
Midkiff, R. B., Ch. Engr. M. of W. & Struc., Sou., Knoxville, Tenn. (1953)
Miller, R. F., B. & B. Supv., N. Y. C. & St. L., Frankfort, Ind. (1960)

Milne, A. P., Supv. B. & B., N. Y. C. & St. L., Frankfort, Ind. (1953)
Mince, F. S., B. & B. Supvr., Sou., Big Stone Gap, Va. (1963)
Mince, G. R., Jr., B. & B. Supvr., Sou., Valdosta, Ga. (1963)
Mitchell, D. N., Asst. Supv. B. & B., C. & O., Newport News, Va. (1948)
Moline, R. F., Br. Engr., D. T. & I., Dearborn, Mich. (1956)
Montague, C. F., Supt. M. W. Equip., P. R. R., Philadelphia, Pa. (1953)
Moore, G. A., Mast. Carp., S. A. L., Savannah, Ga. (1959)
Moore, H. R., Asst. Ch. Engr., Sou., Washington, D. C. (1956)
Morgan, C. E., B. & B. Supvr., S. P., Houston, Tex. (1954)
Moris, R. F., B. & B. Supv., N. Y. C. & St. L., Ft. Wayne, Ind. (1955)
Morris, C. G., Asst. B. & B. Mast., C. N. R., Campbellton, N. B., Canada (1963)
Morris, C. L., Supv. B. & B., L. & N., Mobile, Ala. (1957)
Morris, C. R., Asst. Supvr. B. & B., N. P., Tacoma, Wash. (1962)
Morris, D. W., Supvr. Struct., Cartier, Port Cartier, Que., Canada (1963)
Moser, C. A., B. & B. Supv., W. P. - S. N. - T. W. S., Sacramento, Calif. (1951)
Moser, C. L., Div. Engr., Sou., Asheville, N. C. (1955)
Moutoux, H. G., Sr., Supvr. B. & B., N. Y. C., Weehawken, N. J. (1959)
Muelder, C. F., Asst. to Engr. Bldgs., C. B. & Q., Chicago, Ill. (1960)
*Murawski, H. J., Draftsman, I. C., Chicago, Ill. (1960)
Murray, D. J., Land & Tax Comm., C. & W. I., Chicago, Ill. (1954)
Myers, E. T., Engr. Editor, Modern R. Rs., Chicago, Ill. (1957)
Myers, R. L., Wtr. Chemist, I. C., Mattoon, Ill. (1950)

N

Nash, G. H., Struct. Engr., St. L.-S. F., Springfield, Mo. (1961)
Neal, C. E., Vice Pres. & Gen. Mgr., N. W. P., San Rafael, Calif. (1959)
Neal, G. W., Vice Pres., Secy., Asst. Treas., & Asst. Gen. Mgr., C. V., West Point, Ga. (1948)
Nelson, M. S., Br. Insp., N. Y. C., Lincoln Park, Mich. (1956)
Nelson, R. D., Div. Engr., C. & N. W., Boone, Iowa (1957)
Newlin, C. H., Engr. Br., Sou., Charlotte, N. C. (1959)
Nicely, O. P., Supv. B. & B., C. & O., Clifton Forge, Va. (1950)
Nichols, E. F., Supt.-Maint., B. & S., Fairfield, Ala. (1963)
Nichols, J. C., Br. Engr., L. & N., Louisville, Ky. (1954)
Nichols, R. E., Gen. Fore. B. & B.-W. S., St. L.-S. F., Springfield, Mo. (1957)
Noble, H. H., Incorp., C. & L. C., Lansing, Mich. (1963)
Nord, D. L., Ch. Designer, I. C., Chicago, Ill. (1960)
Nordstrom, R. D., Asst. Engr. Br. & Struc., W. P., San Francisco, Calif. (1959)
Norris, J. M. W., B. & B. Supvr., D. & H., Oneonta, N. Y. (1962)
Nygaard, R., Supt. Wk. Equip., C. N. R., Edmonton, Alta., Canada (1961)

O

O'Brien, J. B., Asst. Supv. B. & B., C. & O., Richmond, Va. (1954)
O'Bryant, C. M., Supvr. Str., T. M., Laredo, Tex. (1962)
Odgers, F. T., Gen. B. & B. Supvr., S. P., San Francisco, Calif. (1955)
Ogle, H., Br. Insp., C. & E. I., Salem, Ill. (1956)
Olson, O. D., B. & B. Supv., C. & N. W., Chicago, Ill. (1953)
Olson, V. E., B. & B. Supvr., S. L., Minneapolis, Minn. (1948)
Orange, W. R., Supvr. B. & B. & W. S., C. & O., Richmond, Va. (1961)
Ornburn, B. J., Asst. Ch. Engr. Struc., C. M. St. P. & P., Chicago, Ill. (1948)
Orphan, A. J., Div. Engr., S. P., Houston, Tex. (1960)
Osland, E., Off. Engr., A. T. & S. F., Chicago, Ill. (1961)
Ostrom, W. D., Ch. Carp., C. M. St. P. & P., La Crosse, Wis. (1954)
Ovardits, K., Asst. Plan. Engr., N. Y. C., Chicago, Ill. (1953)
Owens, B. H., Gen. Fore. B. & B., I. C., Vicksburg, Miss. (1956)

P

Packard, B. G., Off. Engr., C. & N. W., Chicago, Ill. (1954)
Packer, E. B., Jr., B. & B. Supvr., Sou., Birmingham, Ala. (1960)
Pagett, C. H., Supt. Struc. & Material, C. of G., Macon, Ga. (1960)
Palagi, L. A., Engr.-Arch., C. R. I. & P., Chicago, Ill. (1959)
Panushka, E. A., B. & B. Supv., N. P., Fargo, N. D. (1959)
Parvin, C. F., Engr. M. of W., P. R. R., Pittsburgh, Pa. (1959)
Patterson, C. A., B. & B. Supv., T. P. & W., Washington, Ill. (1955)
Patterson, C. C., Mast. Carp., C. B. & Q., Alliance, Nebr. (1958)
Patterson, E. C., Ch. Clk. to Asst. Ch. Engr.-Maint., C. & N. W., Chicago, Ill. (1963)
Patterson, J. M., Supv. B. & B., N. Y. C., Weehawken, N. J. (1957)
Patterson, R. H., Asst. Ch. Engr., St. L. S. W., Tyler, Tex. (1955)

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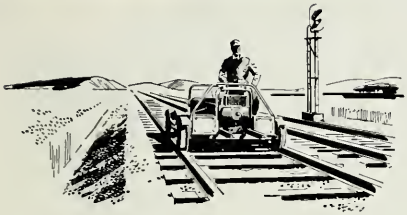

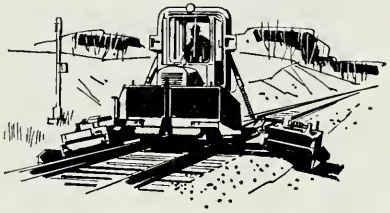

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Payne, G. C., Div. Engr., St. L.-S. F., Cape-ville, Tenn. (1959)
Pearson, A. H., Mast. Carp., C. B. & Q., St. Joseph, Mo. (1952)
Pearson, R. E., Drainage Engr., I. C., Chicago, Ill. (1963)
Peffly, J. E., Asst. B. & B. Supvr., P. E., Los Angeles, Calif. (1958)
Perrier, J. L., Div. Engr., C. & N. W., Chicago, Ill. (1953)
Peterson, E. A., Rdm., S. D. & A. E., San Diego, Calif. (1960)
Peterson, J. M., Br. Engr., C. G. W., Oelwein, Iowa (1959)
Peterson, N. E., Ch. Engr., C. & I. M., Springfield, Ill. (1938)
Phelps, C. E., B. & B. Supv., A. & W. P. - W. of A., & Ga. R. R., Warrenton, Ga. (1949)
Phillips, L. K., B. & B. Insp., W. M., Cumberland, Md. (1957)
Piper, J. F., Asst. Ch. Engr.-Const., P. R. R., Philadelphia, Pa. (1959)
Planchon, I., Gen. Fore. B. & B.-W. S., St. L.-S. F., Tulsa, Okla. (1961)
Plourde, L. (Ret.), Sr. Mast., C. N. R., St. Paul L Ermite, Que., Canada (1963)
Pollock, J. K., Asst. B. & B. Supvr., S. P., Norden, Calif. (1961)
Potts, H. F., Supv. Struc., P. R. R., Ft. Wayne, Ind. (1957)
Pound, E. R., Mast. Carp., B. & O., Newark, Ohio (1952)
Prentiss, E. W., Engr. B. & B., P. R. R., Philadelphia, Pa. (1959)
Presthus, E. J., Supvr. B. & B., N. P., Tacoma, Wash. (1961)
Pritchard, B. L., Div. Engr., A. T. & S. F., Amarillo, Texas (1956)
Pritchett, J. S., Supt. Struct. & Materials, C. of G., Macon, Ga. (1961)
Prober, H. W., Sr. Asst. B. & B. Supv., S. P., Los Angeles, Calif. (1957)
Prude, G. F., Asst. Supvr. B. & B., S. P., Houston, Tex. (1951)
Pruett, J. A., Supt. Fire Prev. & Fuel Supply, S. P., Houston, Tex. (1959)

R

Raessler, V. D., Supv. B. & B., I. C., Memphis, Tenn. (1951)
Rainey, W. H., B. & B. Supvr., S. P., San Antonio, Tex. (1956)
Rankin, R. C., Design. Engr., St. L. S. W., Tyler, Tex. (1962)
Rankin, W. H., Sr. Struct. Engr., St. L.-S. F., St. Louis, Mo. (1961)
Rapier, L. F., Supv. B. & B., G. M. & O., Bloomington, Ill. (1946)
Raver, H. E., Engr. Struc.-Design, L. I., Jamaica, N. Y. (1952)
Ray, M. M., Jr., Asst. Gen. Fore. B. & B., St. L.-S. F., Tulsa, Okla. (1962)
Rea, C. M., B. & B. Supvr., N. P., Minneapolis, Minn. (1962)
Reed, T. C., Br. Insp., L. & N., Louisville, Ky. (1954)
Reese, C. L., Br. Insp., G. M. & O., Philadelphia, Miss. (1958)
Reese, C. M., Gen. Fore. B. & B., G. C. & S. F., Temple, Tex. (1953)
Reynolds, M. L., B. & B. Supvr., S. P., Bakersfield, Calif. (1958)
Reynolds, T. A., Asst. Supvr. Str., P. R. R., Buf.alo, N. Y. (1961)
Rice, E. D., B. & B. Supv., C. & E. I., Danville, Ill. (1949)
Richardson, F, Jr., Gen. Fore. B. & B.-W. S., St. L.-S. F., Memphis, Tenn. (1962)
Ridgeway, J. J., Engr. Struc.-Proc., B. & L. E., Greenville, Pa. (1957)
Riffle, L. R., Ch. Carp., C. M. St. P. & P., Perry, Iowa (1956)
Riggs, W. K., B. & B. Supv., C. & N. W., West Chicago, Ill. (1959)
Riley, C. R., Spl. Asst. to Vice Pres.-O. & M., B. & O., Baltimore, Md. (1959)
Robey, W. E., Br. Engr. Sys., A. T. & S. F., Chicago, Ill. (1960)
Robinson, N. R., B. & B. Fore., S. P., Sacramento, Calif. (1934)
Rode, L. A., Gen. Br. Insp., E.-L., Newark, N. J. (1948)
Rodgers L. T., Mast. Carp., B. & O., Chillicothe, Ohio (1963)
Rogers, L. W., Designer, I. C., Chicago, Ill. (1960)
Rothell, R. D., Gen. B. & B. Supv., Sou., Charlotte, N. C. (1957)
Rothwell, G. F., Engr. Plan., Wabash, St. Louis, Mo. (1961)
Rowland, J. W., Asst. Engr. Const., L. I., Jamaica, N. Y. (1956)
Rudisill, D. E., Asst. Ch. Engr. Maint., P. R. R., Philadelphia, Pa. (1959)
Runde, E. E., Ch. Masonry Insp., I. C., Chicago, Ill. (1959)
Russell, C. E., Supvr. Water Serv., I. C., Chicago, Ill. (1953)
Rust, R. B., Jr., Asst. Div. Engr., Sou., Appalachia, Va. (1957)
Ryan, G. M., Asst. to Gen. B. & B. Fore., N. Y. N. H. & H., New Haven, Conn. (1963)
Rymer, J. R., Div. Engr., B. & O., Cumberland, Md. (1957)

S

Saether, A. H., Design., C. M. St. P. & P., Chicago, Ill. (1959)
Safley, J. R., B. & B. Supv., S. P., San Francisco, Calif. (1945)
St. Pierre, M. P., Asst. B. & B. Mast., C. N., Edmundston, N. B., Can. (1959)
Salmon, J. M., Jr., Ch. Engr., Clinchfield, Erwin, Tenn. (1938)
Sandberg, C. H., Ch. Engr.-East. Lines, A. T. & S. F., Topeka, Kans. (1958)

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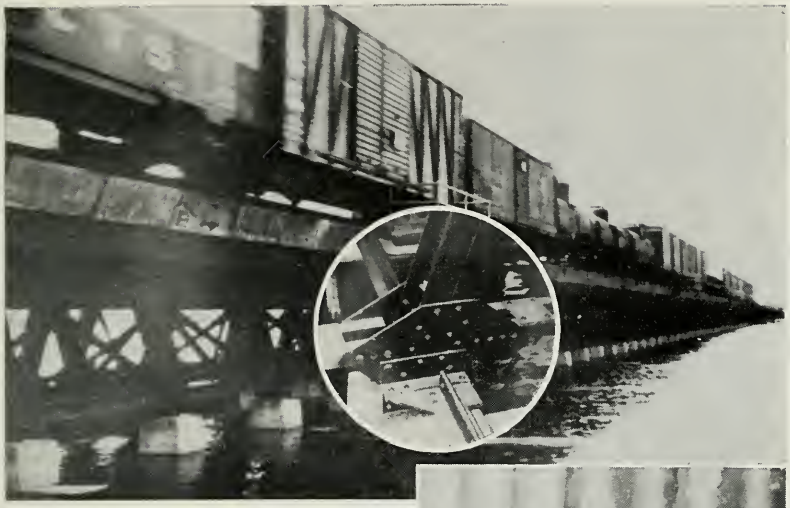
Sanders, G. A., Asst. B. & B. Supvr., S. P., Elko, Nev. (1960)
Sanderson, J. G., Asst. W. S. Fore., St. L.-S. F., Amory, Miss. (1959)
Sarris, P. T., Div. Engr., Sou., Knoxville, Tenn. (1955)
Sartore, D. V., Asst. Engr. Brdgs., C. B. & Q., Chicago, Ill. (1961)
Sathre, C. O., B. & B. Supv., C. & N. W., Madison, Wis. (1950)
Saunders, T. D., Dir. of Plan. & Res., Ont. Nor., North Bay, Ont., Can. (1930)
Savage, F. E., Asst. B. & B. Supv., N. P., Minneapolis, Minn. (1957)
Schlaf, E. R., Supt. Fire Prev., I. C., Chicago, Ill. (1947)
Schmitz, J. F., B. & B. Supt., M. P., Little Rock, Ark. (1960)
Schweitzer, E., Res. Engr., U. P., Hermiston, Ore. (1959)
Scites, P. E., Asst. Supv. B. & B., C. & O., Hinton, W. Va. (1950)
Seitz, H., Engr. of Struct., B. & O., Baltimore, Md. (1959)
Seley, L. L., Mast. Carp., C. B. & Q., Hannibal, Mo. (1953)
Sellers, J. B., Asst. B. & B. Insp., L. & N., Louisville, Ky. (1957)
Seltzer, J. W., Area Engr.-Struct., P. R. R., Cincinnati, Ohio (1958)
Shafer, W. R., Struct. Designer, S. P., Houston, Texas (1963)
Shamblin, R. E., Supv. B. & B., N. & W., Bluefield, W. Va. (1957)
Sharkey, J. J. (Ret.), Gen. Fore. B. & B., P. R. R., Short Hills, N. J. (1951)
Short, W. L., Asst. Engr., M. P., St. Louis, Mo. (1951)
Shultz, E. R., Engr. M. of W. & Struc., P. R. R., Philadelphia, Pa. (1959)
Sielert, E. R., Gen. Fore., A. T. & S. F., Emporia, Kans. (1961)
Simmons, E. R., Supvr. Trk. & Struct., St. L. S. W., Pine Bluff, Ark. (1955)
Simmons, R. G., Gen. Rdm., C. M. St. P. & P., Chicago, Ill. (1957)
Simonson, E. F., B. & B. Supv., S. I., Sandpoint, Ida. (1958)
Simpson, L. W., Mast. Carp., B. & O., Pittsburgh, Pa. (1959)
Sinclair, C. H., Asst. Supv. B. & B., C. & N. W., Milwaukee, Wis. (1954)
Slagle, G. P., Ch. Carp., C. M. St. P. & P., Milwaukee, Wis. (1948)
Smedley, V. N., B. & B. Supv., U. P., Portland, Ore. (1959)
Smith, A. C., Asst. Engr. Brdgs., Sou., Charlotte, N. C. (1963)
Smith, A. E., Asst. Gen. Mgr.-Ch. Engr., C. G. W., Oelwein, Iowa (1958)
Smith, E. L., Gen. B. & B. Supvr., Southern, Rossville, Ga. (1952)
Smith, G. A., Mast. Carp., B. & O., Punxsutawney, Pa. (1959)
Smith, H. E., Pres. & Gen. Mgr., G. H. & H., Galveston, Tex. (1941)
Smith, J., B. & B. Supv., S. P., Sacramento, Calif. (1943)
Smith, L. D., Jr., Asst. Engr.-Bldgs., C. & O., Huntington, W. Va. (1963)
Smith, R. E., Asst. B. & B. Mast., C. N. R., Hornepayne, Ont., Canada (1963)
Smith, R. H., Jr., Dist. Engr., P. R. R., Chicago, Ill. (1957)
Snyder, E. F., Asst. to Ch. Engr., I. C., Chicago, Ill. (1948)
Snyder, R. E., Instrumentman, C. & N. W., Milwaukee, Wis. (1961)
Solarte, H., Struct. Designer, C. R. I. & P., Chicago, Ill. (1963)
South, J. E., Sys. Engr. Struc., P. R. R., Philadelphia, Pa. (1959)
Spofford, F. R., Asst. to Vice Pres.-Oper., B. & M., Boston, Mass. (1940)
Stade, A. F., Asst. B. & B. Supvr., S. P., San Antonio, Tex. (1962)
Stadter, C. O., B. & B. Supt., M. P., Osawatomie, Kans. (1955)
Stanczyk, W., Designer, C. M. St. P. & P., Chicago, Ill. (1957)
Starling, S. L., Asst. Mast. Carp., S. A. L., Savannah, Ga. (1961)
Steel, J. V., Engr. Acct., U. T. Co., Dallas, Tex. (1953)
Stephens, B. M., Asst. Gen. Mgr.-T. & L. Lines, S. P., Houston, Texas (1946)
Stephens, T. J., Engr. Insp., U. P., Kansas City, Mo. (1958)
Stinebaugh, J. H., Supv. W. S. & Rdwy. Mach., I. C., Carbondale, Ill. (1951)
Stouffer, R., Mech. Insp., I. C., Crown Point, Ind. (1961)
Street, M. R., Asst. B. & B. Supvr., G. N., Minot, N. D. (1962)
Struther, B. A., Asst. Div. Engr., S. P., Tucson, Ariz. (1961)
Stumpff, G. A., Asst. Engr., St. L. S. W., Pine Bluff, Ark. (1960)
Sturm, W. C., Designer, E. J. & E., Joliet, Ill. (1962)
Sturman, J. J., Maint. Engr.-Struc., B. & O., Baltimore, Md. (1959)
Stutes, S. A., Asst. Div. Engr., S. P., Lafayette, La. (1959)
Sullivan, P., Engr. Insp., W. P., Oroville, Calif. (1957)
Swanson, A. M., B. & B. Supvr., B. A. & P., Anaconda, Mont. (1961)
Swanson, R. S., B. & B. Supvr., N. P., Duluth, Minn. (1960)
Swanson, W. C., Brdg. Insp., N. Y. C., Knox, Ind. (1963)
Switzer, G., Gen. Supv. Struc. & Wk. Equip., W. P., Oakland, Calif. (1949)



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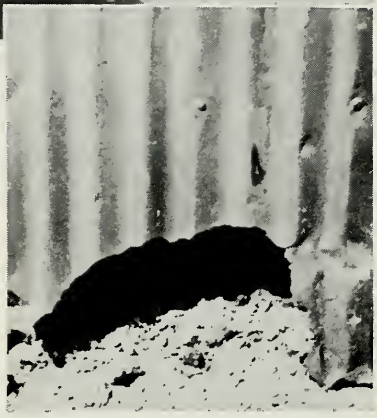

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Tanner, C. L., Gen. Fore. B. & B.-W. S., P. & S. F., Slaton, Tex. (1958)
Tantillo, A. J., Arch. Engr., C. & W. I., Chicago, Ill. (1962)
Tardy, F. E., Asst. Div. Engr., S. P., Tucson, Ariz. (1953)
Taylor, W. L., B. & B. Supv., Sou., Jasper, Ala. (1950)
Termunde, W. L., Asst. Rdm., B. Ry. of C., Chicago, Ill. (1956)
Tetreault, L. J., B. & B. Fore., N. Y. N. H. & H., Providence, R. I. (1936)
Thatcher, C. H., Jr., Asst. Engr., C. & N. W., Boone, Iowa (1958)
Thomas, A. A., Asst. to Ch. Engr., C. & N. W., Chicago, Ill. (1961)
Thrasher, H. A., Asst. B. & B. Mast., C. N., Toronto, Ont., Can. (1957)
Throckmorton, W. B., Ch. Engr., C. R. I. & P., Chicago, Ill. (1957)
Thun, W. A., Jr., Supvr. Trk., P. R. R., Cincinnati, Ohio (1961)
Tieman, L. G., Div. Engr., C. & N. W., Green Bay, Wis. (1956)
Tilley, E. L., Br. Insp., I. C., Memphis, Tenn. (1956)
Toal, T. W., Div. Engr., C. R. I. & P., Blue Island, Ill. (1961)
Towle, C. L., Vice Pres.-Oper., D. T. & I., Dearborn, Mich. (1959)
Tracy, D. E., B. & B. Supvr., S. P., Oakland, Calif. (1956)
Tracy, S. E., Supt. Wk. Equip., C. B. & Q., Chicago, Ill. (1960)
Trenning, D. P., Draftsman, C. M. St. P. & P., Chicago, Ill. (1962)
Trewin, H., Rdm., C. N. R., Moncton, N. B., Canada (1963)
Trickey, R. E., Supt. B. & B., B. & A., Houlton, Me. (1957)
Trulove, J. D., B. & B. Supv., S. P., Ogden, Utah (1945)
Turner, G. M., Asst. B. & B. Supv., N. P., Pasco, Wash. (1960)
Tustin, E. O., Asst. Supvr. B. & B., I. C., Chicago, Ill. (1963)
Tustin, W. S., Draftsman, I. C., Chicago, Ill. (1963)
Tyckoson, E. G., Ch. Carp., C. M. St. P. & P., Chicago, Ill. (1954)
Tyler, W. R., Jr., Div. Engr., U. P., Pocatello, Ida. (1959)

U

Urquides, E. L., Asst. Supvr. B. & B., S. P., West Oakland, Calif. (1960)

V

Vanderpool, G. R., Br. Engr.-West. Lines, A. T. & S. F., Amarillo, Tex. (1959)
Vandiver, V. J., Asst. B. & B. Supv., S. P., Dunsmuir, Calif. (1958)
Van Scoyoc, L., Designer, I. C., Chicago, Ill. (1960)
Veldheer, H., Asst. Supv. B. & B., C. & O., Grand Rapids, Mich. (1959)
Von Behren, G., Asst. Supv. Struc., P. R. R., Baltimore, Md. (1956)

W

Wachtel, C. D., Dist. B. & B. Supt., M. P., Kansas City, Mo. (1958)
Wachter, C. E., B. & B. Mast., C. N. R., Port Arthur, Ont., Canada (1957)
Wade, E. B., Asst. Div. Engr., T. & N. O., San Antonio, Texas (1957)
Waisanen, R. M., Asst. Arch. Engr., C. & N. W., Chicago, Ill. (1963)
Walker, G. P., Supt. B. & B., M. P., Houston, Texas (1929)
Wall, R., Supv. B. & B., Sou., Selma, Ala. (1948)
Walton, K. D., Asst. B. & B. Supv., N. P., Minneapolis, Minn. (1960)
Ward, R. A., B. & B. Mast., C. N. R., Campbellton, N. B., Canada (1961)
Ware, W., Div. Engr., C. R. I. & P., Little Rock, Ark. (1956)
Warfield, H. Jr., (Ret.), Insp. M. of W., P. R. R., New Brunswick, N. J. (1952)
Warfield, W. B., Supv. Struc., P. R. R. - P. R. S. L., Camden, N. J. (1951)
Watanabe, L. H., Designer, I. C., Chicago, Ill. (1963)
Waterman, L. B., Asst. Supt., B. & O., Baltimore, Md. (1959)
Watkins, A. B., B. & B. Supvr., Southern, Alexandria, Va. (1960)
Watkins, J. F., B. & B. Supv., Sou., Tuscumbia, Ala. (1958)
Watson, S. J., Ch. Drafts., C. & N. W., Chicago, Ill. (1961)
Weaver, W. R., Ch. Mech. Off. & Ch. Engr., P. & S., Brookville, Pa. (1951)
Webber, G. R., B. & B. Fore., C. M. St. P. & P., Tacoma, Wash. (1948)
Weikal, J. K., Div. Engr., E.-L., Youngstown, Ohio (1959)
Weller, M. E., Sr. Designer, E. J. & E., Joliet, Ill. (1962)
Weller, R. C., Asst. Engr. Maint., C. N. R., London, Ont., Canada (1957)
Wenzel, J. R., B. & B. Supvr., C. & N. W., Norfolk, Nebr. (1963)
Westerman, C. J., Asst. B. & B. Supvr., S. P., Bakersfield, Calif. (1962)
White, E. K., Asst. Gen. Brdg. Insp., C. & N. W., Stone Park, Ill. (1961)
White, L. H., Supv. B. & B., I. C., New Orleans, La. (1946)
White, R. D., Div. Engr., St. L. - S. F., Amory, Miss. (1959)
White, S., Gen. B. & B. Supv., S. P., San Francisco, Calif. (1946)
Whitehead, D. E., B. & B. Supvr., C. & N. W., Mason City, Iowa (1961)
Wiemer, H. C., B. & B. Supvr., N. P., Tacoma, Wash. (1957)
Wiklund, W. W., Asst. Supvr. B. & B., G. N., Whitefish, Mont. (1955)

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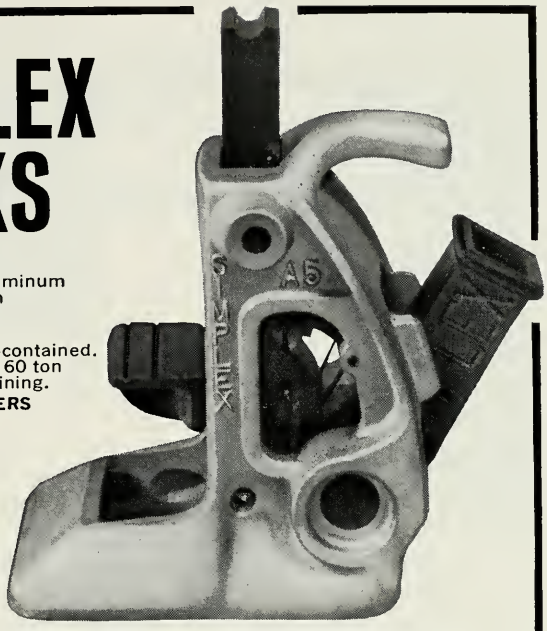

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Williams, D. R., Br. Insp., C. & E. I., Danville, Ill. (1956)
Williams, J. M., Masonry Insp., I.C., Chicago, Ill. (1963)
Williams, J. R., Engr. Brdgs., C. R. I. & P., Chicago, Ill. (1959)
Williams, N. H., Trk. Supv.-Sys., D. & H., Albany, N. Y. (1947)
Williams, T. S., Engr. Bldgs., S. A. L., Richmond, Va. (1961)
Williamson, H. M., Ch. Engr.-Sys., S. P., San Francisco, Calif. (1960)
Wilson, H. E., Asst. Ch. Engr.-Sys., A. T. & S. F., Chicago, Ill. (1959)
Wilson, H. M., Supv. Struc., P. R. R., Chicago, Ill. (1953)
Wilson, R. P., Supv. B. & B., C. & O., Hinton, W. Va. (1948)
Wintoniak, S. G., Area Engr.-Struct., P. R. R., Baltimore, Md. (1953)
Wohlschlaeger, M. W., Engr. Grade Separat., M. P., St. Louis, Mo. (1958)
Wold, O. R., B. & B. Supv., N. P., Spokane, Wash. (1957)
Wood, R. E., Supv. B. & B., G. N., Great Falls, Mont. (1954)
Woolford, F. R., Ch. Eng., W. P., San Francisco, Calif. (1950)
Worden, R. K., Gen. Fore. B. & B.-W. S., G. C. & S. F., Ft. Worth, Tex. (1954)
Wright, R. J., Asst. Brdg. Engr., C. M. St. P. & P., Chicago, Ill. (1960)

Y

Yaw, D. M., Mast. Carp., E.-L., Buffalo, N. Y. (1951)
Youngblood, R. A., Proc. Supt. B. & B., C. of G., Savannah, Ga. (1957)

Z

Zapfe, E. J., (Ret.), Asst. Ch. Engr. & Supt. B. & B., G. B. & W., Green Bay, Wis. (1952)
Zigler, L. A., Gen. Fore. B. & B.-W. S., A. T. & S. F., La Junta, Colo. (1961)
Zimmerman, C. B., Asst. Arch., Sou., Knoxville, Tenn. (1957)

LIFE MEMBERS

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A

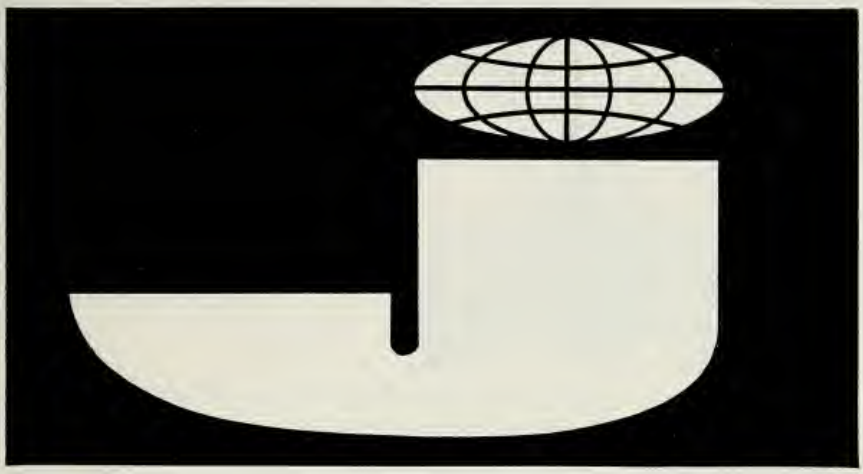
Anderson, A. (Ret.), Engr. Grade Cross., N. Y. C., Bear Creek Canon, Rosemont Route, Colorado Springs, Colo. 1947
Anderson, J. L. (Ret.), Supv. B. & B., M. P., 136 Pacific St., Osawatomie, Kans. 1931
Anderson, R. D., (Ret.), Div. Engr., C. & N. W., Marvin Hughitt Hotel, Huron, S. D. .. 1923

B

Babbitt, J. H., (Ret.), Asst. Div. Engr., B. & O., 220 Virginia Ave., Indianapolis 4, Ind. 1946
Barr, H. L., (Ret.), Div. Engr., C. & N. W., 945 E. 6th St., Chadron, Nebr. 1938
Block, M., (Ret.), Asst. to Ch. Engr., I. C., 7147 S. Jeffery Blvd., Chicago 49, Ill. 1948
Borchert, W. C. (Ret.), Div. Engr., L. & A., 917 Stephenson St., Shreveport 38, La. 1942
Bost, M. A., (Ret.) Asst. Engr., C. M. St. P. & P., 322 S. Carolina, Mason City, Iowa ... 1935
Brice, W. T., (Ret.), B. & B. Mast., C. N., General Delivery, Riverhurst, Sask., Can. 1946
Burch, E. E., (Ret.), Brdg. Engr., C. M. St. P. & P., 3926 W. 147th Place, Midlothian, Ill. 1945
Budzenski, F. N., (Ret.), Gen. Fore., C. & N. W., 800 Pine St., Antigo, Wis. 1938
Bunge, W. H. (Ret.), Asst. Engr., M. P., 4510 Waring, Houston 27, Texas 1941

C

Carothers, M. D., (Ret.), Asst. Ch. Engr., G. M. & O., 8605 Wenouga Lane, Leawood, Kans. 1938
Carter, J. W. (Ret.), B. & B. Supv., Virginian, 2410 Brandon Ave., S. W., Roanoke, Va. 1947
Chaney, A. B., (Ret.), Engr. M. of W., M. P., 3 Sun Valley Rd, Little Rock, Ark. 1947
Christianson, H. B., (Ret.), Sp. Engr., C. M. St. P. & P., 997 Bob O'Link Rd., Highland Park, Ill. 1928
Church, H. M., (Ret.), Gen. Supv. B. & B., C. & O., 509 No. Blvd., Richmond, Va. 1939



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Converse, D. W., (Ret.), Br. Engr., A. C. & Y., 360 Litchfield Road, Akron, Ohio 1940
Cota, G. M., (Ret.), Ch. Clk., Engr. Dept., C. of V., Box 114, St. Albans, Vt. 1913
Cramer, F. H., (Ret.), Br. Engr., C. B. & Q., 2739 Agatite Ave., Chicago, Ill. 1927

D

Decker, H. H., (Ret.), Engr. of M., C. & N. W., 2915 Ingersoll Ave., Des Moines, Ia. 1908
Dick, H. M., (Ret.), Supv. Struc., P. R. R., 302 Walnut Circle, Shiremanstown, Pa. 1942
Duchac, J. V. (Ret.), Supv. B. & B., C. & N. W., 525 Virginia St., Antigo, Wis. 1927
Duffie, F. J., (Ret.), Engr. Serv. Rep., Oxweld R. R. Dept., Linde Co., 610 W. 6th St., Sterling, Ill. 1946

E

Eischenlaub, C. M. (Ret.), Supt., S. D. & A. E., San Diego, Calif. 1943
Engman, V. E., (Ret.), Ch. Carp., C. M. St. P. & P., 2936 44th Ave., So., Minneapolis, Minn. 1920

F

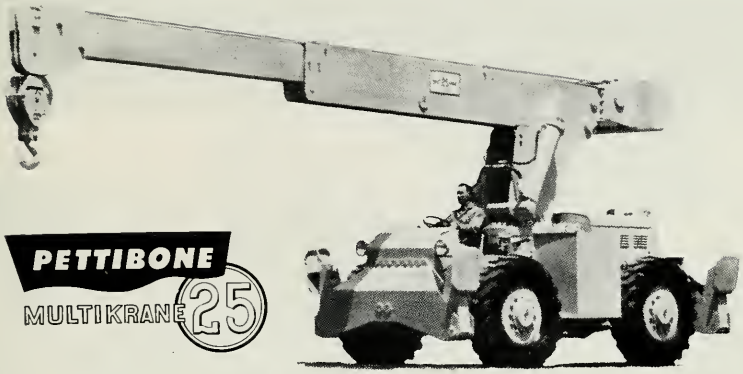
Firehammer, L. M., (Ret.), Supvr. B. & B., I. T., 213 E. Elm St., Gillespie, Ill. 1919
Flanagan, F. L., (Ret.), Ry. Sls., Valspar Corp., Detroit Graphite Div., 7701 W. 47th St., Lyons, Ill. 1937
Fronabarger, H. C., (Ret.), B. & B. Supvr., T. & P., 554 S. Summitt Ave., Apt. 1119, Ft. Worth, Tex. 1949

G

Geyer, C. J., (Ret.), Vice Pres., C. & O., 1412 Wilmington Ave., Richmond, Va. 1928
Gillette, J. E., (Ret.), Carp. Fore., C. M. St. P. & P., c/o Herman Nursing Home, Black Earth, Wis. 1923
Glander, A. M., (Ret.), Ch. Carp., C. M. St. P. & P., 2008 Lake Shore Dr., Austin, Minn. 1936
Gunderson, E., (Ret.), Supt. B. & B., C. St. P. M. & O., Altoona, Wis. 1927

H

Hampton, A. A., (Ret.), Supvr. B. & B., M. P., 903 S. Second St., Monroe, La. 1947
Hancock, J. S., (Ret.), Brdg. Engr., D. T. & I., 4921 Calhoun Ave., Dearborn, Mich. 1916
Harman, W. C., (Ret.), Supv. B. & B., S. P., 656 Cedar St., San Carlos, Calif. 1911
Harris, A. R., (Ret.), Engr. Brdgs., C. & N. W., 1440 Regina Dr., West, Largo, Fla. 1940
Heiszenbuttel, H., (Ret.), B. & B. Supv., C. & N. W., 808 So. 3rd St., Norfolk, Neb. 1917
Hemstad, B., (Ret.), Mast. Carp., G. N., 1120 Becker Ave., West, Willmar, Minn. 1937
Hillman, A. B., (Ret.), Ch. Engr., Belt Ry. of Chi.-C. & W. I., 7513 S. Carpenter St., Chicago 20, Ill. 1942
Hillman, F. W. (Ret.), Asst. Engr. M. of W., C. & N. W., 1106 N. Harlem Ave., River Forest, Ill. 1917
Huckstep, W. A., (Ret.), Gen. Bldg. Supvr., M. P., Park LaJolla Apts., 5331 LaJolla Blvd., LaJolla, Calif. 1941
Huntsman, F. C., (Ret.), Asst. Engr., Wabash, 416 Oak, Macon, Mo. 1922
Hutcheson, W. A., (Ret.), Supvr. Wk. Equip., C. & O., 620 Douglas St., Clifton Forge, Va. 1939
Hutchings, V. W., (Ret.), B. & B. Supvr., S. P., 3594 E. Central, Fresno, Calif. 1941



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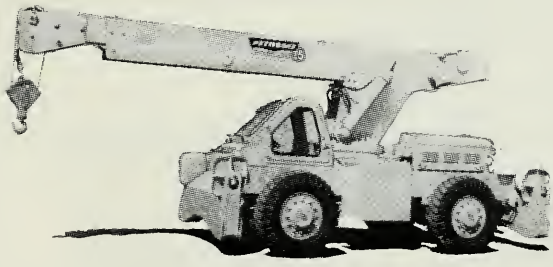

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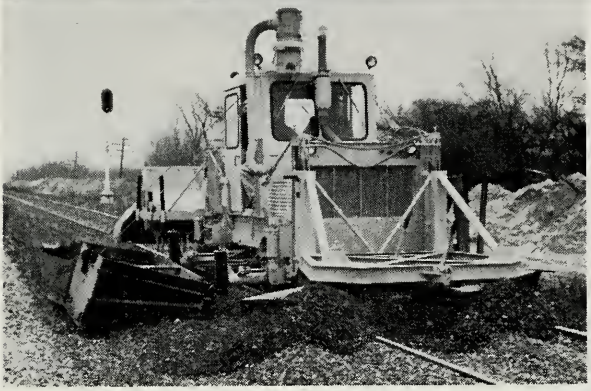

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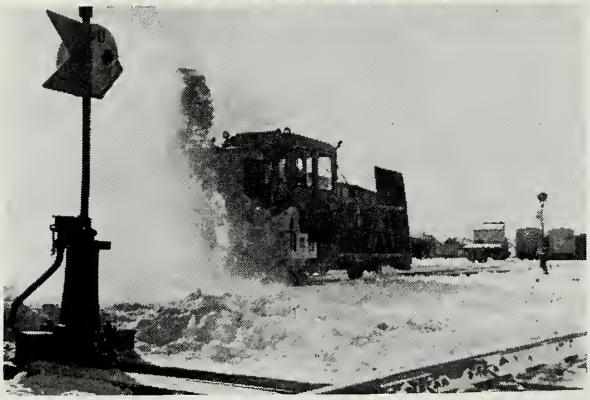

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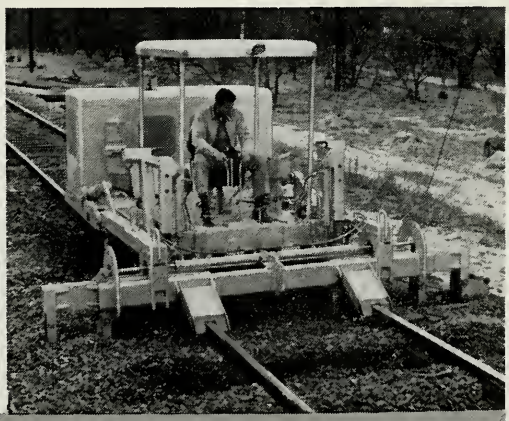
After the old tie has been removed the Kershaw Tie Bed Scarifier scorifies (DOES NOT DESTROY) the old tie bed and then inserts the new tie. Only one operator and a helper are required to insert the new tie.



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Inabinet, J. V. (Ret.), Gen. Brdg. Insp., S. A. L., 1142 Monterey St., Jacksonville, Fla. 1948

J

Jackman, H. E., (Ret.), Mast. Carp., B. & O., 570 Eastern Ave., Chillicothe, Ohio 1944
Jackson, T. E., (Ret.), Gen. B. & B. Supvr., S. P., 144 Sickles Ave., San Francisco, Calif. 1940
Johnson, B. O., (Ret.), Off. Engr., C. M. St. P. & P., 728 Avenida Feliz, Tucson, Ariz. 1931
Johnson, D. H., (Ret.), Supvr. B. & B., C. St. P. M. & O., 1342 Edgerton St., St. Paul 1, Minn. 1940
Johnson, R. W., (Ret.), Asst. Engr., C. M. St. P. & P., 1131 Ave. C., Yuma, Ariz. 1922
Jones, A. C., (Ret.), B. & B. Supv., Sou., Rt. 3, Box 1003, Birmingham 13, Ala. 1938

K

Kemmerer, W. G., (Ret.), Engr. B. & B., P. R. R., 508 Rockavon Rd., Narberth, Pa. 1931
Kvenberg, S. E., (Ret.), Supvr. Bldg. Maint., C. M. St. P. & P., 123 Stanton Point Rd., Ingleside, Ill. 1932

L

Lacher, W. S., (Ret.), Secy., A. R. E. A., 407 E. Fuller Rd., Hinsdale, Ill. 1922
Lampson, W., (Ret.), Supv. B. & B., M. C., 170 Caleb St., Portland, Me. 1930
Lord, H. T., (Ret.), B. & B. Mast., C. P., 415 Third St., So., Kenora, Ont., Can. 1940
Luck, R. P., (Ret.), Drafts., C. & N. W., 2429 W. Farragut Ave., Chicago 25, Ill. 1920
Luther, L. A., (Ret.), Serv. Engr., Ingersoll Rand Co., 1121 Hamilton Ave., Palo Alto, Calif. 1945

Mc

McDaniel, W. L., (Ret.), Vice Pres., American-Marietta, 701 Fairhope Ave., Fairhope, Ala. 1945
McKay, A. G., (Ret.), Supv. B. & B., N. Y. N. H. & H., 11 Pine Island Road, Jupiter Pt., Groton, Conn. 1915
McMahon, T. D., (Ret.), Arch., G. N., 223 Lake Avenue, White Bear Lake 10, Minn. 1918

M

Madson, H. C., (Ret.), Design., C. & N. W., 1327 Curtiss Ave., Ames, Iowa 1940
Manley, B. F., (Ret.), Supv. B. & B., P. E., Los Angeles, Calif. 1916
Manning, D. A., (Ret.), Supv. B. & B., C. & N. W., 9120 Sherman Ave., Brookfield, Ill. 1939
Martens, W. F., (Ret.), Gen. Fore. B. & B., A. T. & S. F., 3396 Mayfield Ave., San Bernardino, Calif. 1924
Mateer, W. G. (Ret.), Mgr. Pur. & Stores, E. J. & E., 511 W. Jefferson St., Joliet, Ill. 1944
Mayfield, L., (Ret.), Prin. Asst. Engr., M. P., 4036 Gilbert Dr., Shreveport, La. 1944
Meeks, W. R., (Ret.), B. & B. Supvr. M,. P., 727 Eldon Dr., Lincoln 10, Nebr. 1942
Merwin, P. B., (Ret.), Asst. Engr., C. & N. W., 8951 S. E. Fuller Road, #7 Pierson's Mobile Club, Portland 66, Oreg. 1929
Moore, I. A., (Ret.), Ch. Engr., C. & E. I., 2321 N. Vermilion St., Danville, Ill. 1937
Mottier, C. H., (Ret.), Vice Pres., I. C., 135 East Eleventh Place, Chicago, Ill. 1942

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Nies, A. B., (Ret.), Arch., N.Y.C. System, 408 Third St., Jackson, Mich. 1915

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O'Brien, W. J., (Ret.), Dist. Carp., C.M.St.P. & P., Juneau County, Necedah, Wis. 1919
Oest, W. C., (Ret.), Prin. Asst. Engr., Ft. W. & D., 4633 Calmont, Ft. Worth, Texas 1947

P

Parker, W. V., (Ret.), Gen. Fore. B. & B., St. L. S. W., R. R. #1, Box 122, Arlington, Tenn. 1911
Pfeiffer, A., (Ret.), Asst. B. & B. Supvr., S. P., 58 Sandburg Dr., Sacramento 19, Calif. 1939
Phillips, W. J., (Ret.), Asst. Gen. Br. Insp., S. P., 318 Arlington Ave., Berkeley, Calif. 1925
Piccone, C., (Ret.), Br. Engr., Nat.Rys. of Mex., Monte Everest 210, Lomas de Chapultepec, Mexico City, Mex. 1923
Podas, N. F., (Ret), Ch. Engr., St. P. U. D. Co. & M. T. Ry. Co., 1238 Randolph Ave., St. Paul 5, Minn. 1937

R

Richards, C. A. J., (Ret.), Asst. Supv. Struc., P. R. R., 2717 Woodland Hills Ave., Lakeland, Fla. 1924
Rights, H. T., (Ret.), Asst. Br. Engr., L. V., 1015 Raymond Ave, Bethlehem, Pa. 1927
Rintoul, D. T., (Ret.), Gen. Br. Insp., S. P., 2571 Glen Green, Hollywood 28, Calif. 1910
Robinson, G. E., (Ret.), Asst. Ch. Engr., N. Y. C., 12 Hillwood Ave., Metuchen, N. J. 1948
Roof, W. R., (Ret.), Br. Engr., C. G. W., 7728 So. Yates Ave., Chicago 49, Ill. 1927
Rowland, O. F., (Ret.), Asst. Engr., D. & H., c/o Berkshire Industrial Farm, Canaan, N. Y. 1923

S

Scheetz, F. B., (Ret.), Asst. Engr., M. P., c/o Cosmos Club, 2121 Massachusetts Ave., N. W., Washington 8, D. C. 1905
Shobert, F., (Ret.), Sys. Steel Const. Fore., S. P., 419 Pope St., Menlo Park, Calif. 1918
Singer, E. W., (Ret.), Supv. B. & B., N. Y. C. & St. L., 6727 3rd Ave. North, St. Petersburg, Fla. 1923
Smith, C. E., (Ret.), Vice Pres., N.Y. N.H. & H., 282 Prospect St., New Haven, Conn. 1911

T

Taggart, C. R., (Ret.), Supv. B. & B., N. Y. C., 514 N. Drexel Ave., Indianapolis, Ind. 1935
Tattershall, E. R., (Ret.), Supv. of Maint. Equip., N.Y.C., 21 Clay St., Malone, N. Y. 1913
Thelander, P. V., (Ret.), Asst. Ch. Engr., C. & N. W., 809 N. E. Conway Blvd., Port Charlotte, Fla. 1939
Todd, D. C., (Ret.), Asst. Engr., P. R. R., Wilmington, Del. 1942
Tourtellotte, E. B., (Ret.), Asst. Div. Engr., B. & M., 15 Franklin St., Greenfield, Mass. 1947
Truss, F. W., (Ret.), Mgr. R. R. Sls., Armco Drainage & Metal Prod., 701 Park St., Paris, Tenn. 1946
Tucker, N. R., (Ret.), Asst. Div. Engr., T. & N. O., Houston, Tex. 1939

V

VanNess, R. A., (Ret.), Brdg. Engr.-Sys., A. T. & S. F., 100 Crescent Dr., Sebring, Fla. 1949
Varker, J. L., (Ret.), Spec. Engr., D. & H., 21 Archbald St., Carbondale. Pa. 1936
von Sprecken, T. M. (Ret.), Asst. to Ch. Engr.-Sys., Sou., 3845 N. Chesterbrook Rd., Arlington 7, Va. 1938

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Walden, W. H., (Ret.), Rdm., Southern, 1012 Porter St., Richmond 24, Va. 1920
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Wang, A. B., (Ret.), Supvr. B. & B., Monon, 303 Murphy St., Lafayette, Ind. 1950
Whitehouse, B. M., (Ret.), Ch. Fire Insp., C. & N. W., 2008 Isabella St., Evanston, Ill. 1927
Wray, H. O., (Ret.), Secy. & Ch. Engr., T. C. T., 511 Bay Street, P. O. Box 1054, Texas City, Tex. 1939

Y

Yewell, J. E., (Ret.), Ch. Engr., B. & L. E., 32 Second Ave., Greenville, Pa. 1941

ASSOCIATE MEMBERS

Joined In

B

Bell, C. R., Jr., Vice Pres., Quaker City R. R. Sls. Co., 3207 Kensington Ave., Philadelphia 34, Pa. 1960
Berkel, C. J., Berkel & Co. Contractors, Inc., P. O. Box 335, Bonner Springs, Kans. 1959
Bernes, A. L., Coating Slsman., The Dow Chemical Co., 6000 W. Touhy Ave., Chicago, Ill. 1961
Bishop, D. B., Dist. Mgr., Dearborn Chemical Co., 2 Gateway Center, Pittsburgh 22, Pa. 1946
Blackford, W. A., Sls. Engr., Pettibone Mulliken Corp., 593 Market St., Ste. 809, San Francisco, Calif. 1960
Boatright, D. D., Dist. R. R. Mgr., Chipman Chem. Co., Inc., 1125 15th Ave., N., Bessemer, Ala. 1962
Bredberg, R. E., Staff Engr., G. A. Heft & Co., 820 Union St., New Orleans, La. 1962
Brietzke, W. F., Mgr. R. R. Mach., Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill. 1956
Brown, S. C., Adv. Mgr., American Hoist & Derrick Co., 63 S. Robert St., St. Paul 7, Minn. 1960
Bugbee, W. E., Railway Equip. & Supplies, 1804 Alamo National Bldg., San Antonio, Texas 1956

C

Campbell, H. D., Sls. Rep., Kershaw Mfg. Co., Inc., 2205 W. Fairview Ave., Montgomery, Ala. 1961
Carmichael, R. L., Dist. Sls. Mgr., R. R. Prod. Div., American Brake Shoe Co., 530 5th Ave., New York, N. Y. 1960
Carpenter, R. W., East. Sls. Mgr., True Temper Corp., 8905 Pinyon Rd., Richmond 29, Va. 1960
Cavins, K., Vice Pres., Fairmont Railway Motors, Inc., 332 S. Michigan Ave., Chicago, Ill. 1960
Clark J. G., Pres., Clark, Dietz, Painter & Assoc., Engrs., 211 N. Race Street, Urbana, Ill. 1963
Comp, R. O., Jr., Sls. Mgr., Buckeye Iron & Brass Works, P. O. Box 883, Dayton 1, Ohio 1960
Cone, D. P., Pres., American Concrete Crosstie Corp., P. O. Box 11476, Tampa 10, Fla. 1960
Corporon, F. J., R. R. Acct. Exec., Motorola Comm. & Electronics, Inc., 308 Earl Road, Michigan City, Ind. 1950
Cox, E. W., Mgr. Ry. Sls., W. T. Cox Co., 580 Hiway 54 West, Camdenton, Mo. 1960
Creed, T. F., Jr., Res. Mgr., Sverdrup & Parcel and Assoc., Inc., Rm. 1509, Barnett Natl. Bank Bldg., Jacksonville, Fla. 1962

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Crosby, R. C., Vice Pres., Kershaw Mfg. Co., P. O. Box 1711, Montgomery 1, Ala. 1961
Cross, E. T., Vice Pres., Armco Steel Corp., 1001 Grove St., Middletown, Ohio 1946
Cummins, C. P., Br. Engr., St. L. Co. Div. of Hiways, Clayton, Mo. 1948

D

Davidson, T., Asst. Mgr., Globe Chemical Company, 80 E. Jackson Blvd., Chicago, Ill. . . 1955
Davis, V. W., Mgr. R. R. Sls., Metal Prod. Div., Armco Steel Corp., P. O. Box 1343, Atlanta, Ga. 1960
Denton, J. H., Sls. Engr., Southern Amiesite Asphalt Co., 3401 5th Ave., N., Birmingham, Ala. 1958
Detzel, G. E., Geo. E. Detzel Co., 1231 Draper St., Cincinnati 14, Ohio 1945
Deubel, H. R., Mgr. RR. Div., Chicago Pneumatic Tool Co., 936 E. 87th St., Chicago 19, Ill. 1956

E

Enstrom, W. A., Mgr. Trk. Mat'ls. Div., Pettibone Mulliken Corp., 4710 W. Division St., Chicago, Ill. 1956
Evans, R., R. R. Sls. Engr., Metal Prod. Div., Armco Steel Corp., 20 N. Wacker Dr., Chicago 6, Ill. 1959
Evinger, F. W., R. R. Rep., The Leon Co., 3243 Euclid Ave., Apt. #2A, Berwyn, Ill. . . . 1946

F

Fechtner, O. R., Div. Prod. Mgr., Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill. 1956
Femberg, H. D., Pres., Oh-Zo-Dry Co., Inc., Tonganoxie, Kans. 1961
Flinn, L. E., Asst. Vice Pres., Dearborn Chemical Co., R. R. Div., 11 N. Broadway, Des Plaines, Ill. 1949
Franzen, E. T., Consult. Engr., Alfred Benesch & Co., 10 S. Wabash Ave., Chicago 3, Ill. 1957
Frederick, H. Z., Mgr. Sls.-Transp. Div., The R. C. Mahon Co., P. O. Box 4666, Detroit 34, Mich. 1950
Fugett, G. C., Sls. Mgr. R. R. Div., Daubert Chemical Co., 4700 S. Central, Chicago, Ill. 1962

G

Giles, J. M., Spl. Rep., Off-Track Equip., Caterpillar Tractor Co., Peoria 8, Ill. 1938
Grego, L. A., Sls. Engr. RR. Div., Pettibone Mulliken Corp., 141 W. Jackson Blvd., Chicago 4, Ill. 1956
Griffin, B. A., Sls. Rep., Fabreeka Prod. Co., Inc., 8137 N. Ridgeway Ave., Skokie, Ill. 1963
Gunther, E. C., Dist. Sls. Mgr., Duff Norton Co., 4937 W. Belmont Ave., Chicago 41, Ill. 1960
Guest, W. H., Sls. Mgr., McKiernan-Terry Div.-Litton Systems, Inc., 505 Manor Ave., Harrison, N. J. 1962

H

Haarvei, O. A., Sls. Engr., Spider Staging Sls. & Serv. Co., 511 Frances Ave., Loves Park, Ill. 1958
Haigh, S. H., Pres., Stan H. Haigh Co., 333 First Federal Bldg., St. Paul 1, Minn. 1961
Hansen, D. G., Ry. Sls. Mgr., Lewis Bolt & Nut Co., 504 Malcolm Ave., S. E., Minneapolis 14, Minn. 1962
Heald, J., Sls. Mgr., Nebraska Prestressed Concrete Co., 630 Cornhusker Highway, Lincoln, Nebr. 1962
Hickey, J. F., Pres., Baker & Hickey Co., P. O. Box 5008, Tri-Village Sta., Columbus 12, Ohio 1946
Hoelzel, W. N., Asst. Vice Pres. Sls., Screw & Bolt Corp. of America, Gary Div., 122 S. Michigan Ave., Chicago 3, Ill. 1949

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Hofer, P., East. Area Mgr., Pettibone Mulliken Corp., R. R. Mach. Div., 5720 Empire State Bldg., New York 1, N. Y. 1956
Holmberg, V. V., Vice Pres., The Ellington Miller Co., 310 S. Michigan Ave., Chicago 4, Ill. 1942
Holmes, J. L., Rep., Bird Tie Pads, Inc., 721 Second Ave., West Haven, Conn. 1956
Holstein, F. W., Pres., Fred W. Holstein Co., Hopatcong, N. J. 1948
Hopkins, W. S., Jr., Process Equip. Tech., Air Reduction Sales Co., 19352 Chicago Ave., Lansing, Ill. 1949
Howe, A. K., Staff Engr.-Tech. Serv., Sika Chemical Corp., 35 Gregory Ave., Passaic, N. J. 1962

I

Itter, R. C., Sls. Corresp., Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill. 1957

J

Jackson, L. E., Sls. Mgr., Ken-Ray Brass Prod., Inc., Vermont, Ill. 1961
Jacobson, A. E., (Ret.), Serv. Engr., Linde Air Prod. Co., 230 N. Michigan Ave., Chicago, Ill. 1950
Johnson, I. K., Const. Supt., Linnan Const. & Engr., Inc., 3958 N. 54th St., Milwaukee 16, Wis. 1953
Johnson, S. C., Exec. Secy., Association Track & Structure Suppliers, 332 S. Michigan, Ave., Chicago, Ill. 1960
Johnson, W. A., Reg. Engr., Metal Prod. Div., Armco Steel Corp., 2180 Milvia St., Berkeley, Calif. 1961

K

Kalousek, H. L., Pres., Air Placement Equipment Co., 1000 W. 25th St., Kansas City, Mo. 1963
Kellogg, J., RR. Sls. Rep., National Lead Co., 111 Broadway, New York 6, N. Y. 1956
Kelly, R. J., Kelly System Inc., 422 N. Western Ave., Chicago, Ill. 1958
Kensel, R. G., Asst. Mgr., Continental Oil Co., 400 W. Madison St., Chicago, Ill. 1961
Kent, E. L., Jr., Sls. Engr., Coast Paint & Lacquer Co., P. O. Box 1113, Houston 1, Tex. 1962
Kleinkort, J. P., Prod. Mgr., American Brake Shoe Co., 155 N. Wacker Drive, Chicago, Ill. 1960
Klosk, L., Pres., Railroad Maintenance Corp., 1555 Grand Concourse, New York 52, N. Y. 1959
Krueger, T. W., Vice Pres. & Gen. Mgr., Duff-Norton Co., P. O. Box 1719, Charlotte 1, N. C. 1960

L

Lacey, J. W., Rep. R. R. Dept., Union Carbide Corp., Linde Div., 230 N. Michigan Ave., Chicago 4, Ill. 1946
Langguth, R. W., R. R. Sls. Engr., Metal Prod. Div., Armco Steel Corp., 4345 Lyndale Ave., No., Minneapolis 12, Minn. 1960
Layer, J. P., Reg. Engr.-R. R., Armco Steel Corp., Metal Prod. Div., P. O. Box 170, Middletown, Ohio 1960
Leff, L. J., Dept. Head, Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill. 1960
Lehmkuhl, E. J., Sls. Mgr., Arcair Co., P. O. Box 406, Lancaster, Ohio 1960
Leyh, G. F., Ry. Rep., Portland Cement Association, 33 W. Grand Ave., Chicago 10, Ill. 1963
Lipscomb, W. P., Reg. Engr., Armco Steel Corp., Metal Prod. Div., P. O. Box 1699, Houston, Tex. 1956
Lunde, A. C., Ry. Sls., Detroit Graphite Div., The Valspar Corp., 7701 W. 47th St., Lyons, Ill. 1959

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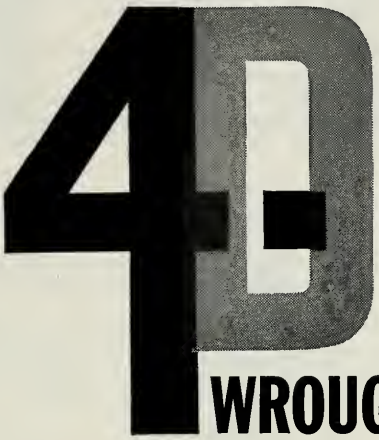

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Lynch, J. K., Secy.-Treas., Huntsville Concrete Pipe Co., Inc., 13209 S. Memorial Parkway, Huntsville, Ala. 1951
Lyon, C. A., Vice Pres., Empire Bldg., #10, Tango-cho, Akasaka Minato-ku, Tokyo, Japan 1945

Mc

McDuff, L. H., Secy.-Treas., W. R. Fairchilds Construction Co., Ltd., P. O. Box 31, Hattiesburg, Miss. 1963
McGough, J. P., Salesman, Fabreeka Prod. Co., Inc., 8137 N. Ridgeway Ave., Skokie, Ill. 1963
McMahon, R. D., Div. Mgr., Fabreeka Prod. Co., Inc., 15 St. Albans Circle, Newton Square, Pa. 1955

M

Mabry, D. B., Mgr. Lumb. Sls., T. J. Moss Tie Co., 700 Security Bldg., St. Louis, Mo. 1948
Mains, W. W., Vice Pres., Armco Steel Corp., Metal Prod. Div., P. O. Box 2170, Denver, Colorado 1960
Mann, E. A., Vice Pres., Modern Supply Co., 222 W. Adams St., Chicago 6, Ill. 1951
Mann, R. E., Pres., Modern Supply Co., 222 W. Adams St., Chicago 6, Ill. 1961
Mayhall, G. A., Mayhall Builders, 12103 S. 75th Ave., Palos Heights, Ill. 1961
Miller, R. H., Oper. Mgr., Matisa Railweld, Inc., 1020 Washington, Chicago Heights, Ill. 1953

N

Needham, L. H., Ch. of Board, The Penetryn System, Inc., 2294 Scranton Rd., Cleveland, Ohio 1946
Nicholson, L. P., Field Engr., Portland Cement Association, 816 West Fifth St., Los Angeles 17, Calif. 1958

P

Patterson, R., Const. Consult., 80 E. Jackson Blvd., Chicago 4, Ill. 1946
Patton, R. C., Roy C. Patton Co., 3416 Silver Palm Rd., Jacksonville Beach, Fla. 1952
Pepple, R. L., Reg. Engr.-R. Rs., Armco Steel Corp.-Metal Prods Div., 10 S. Brentwood Blvd., St. Louis 5, Mo. 1961
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Phillips, R. O., Mgr. Tech. Serv., Research & Development Associates, 909 N. Main. St. Ft. Worth, Texas 1961
Piepmeier, A. L., Vice Pres., Turner Engineering Co., 112 Union St., Nashville 3, Tenn. 1953
Polk, P. W., Vice Pres. & Gen. Mgr., Buckeye Iron & Brass Works, P. O. Box 883, Dayton 1, Ohio 1960

R

Reilly, W. C., Director Person. & Asst. Sls. Mgr., Conley Frog & Switch Co., 362 Bodley Ave., Memphis 9, Tenn. 1960
Robinson, I. C., Reg. Engr. R. R., Armco Steel Corp., Metal Prod. Div., P. O. Box 2170, Denver, Colo. 1962
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S

Scroggs, J. E., Mgr. R. R. & Dist. Divns., Carter-Waters Corp., 2440 Pennway, Kansas City, Mo. 1958

KR

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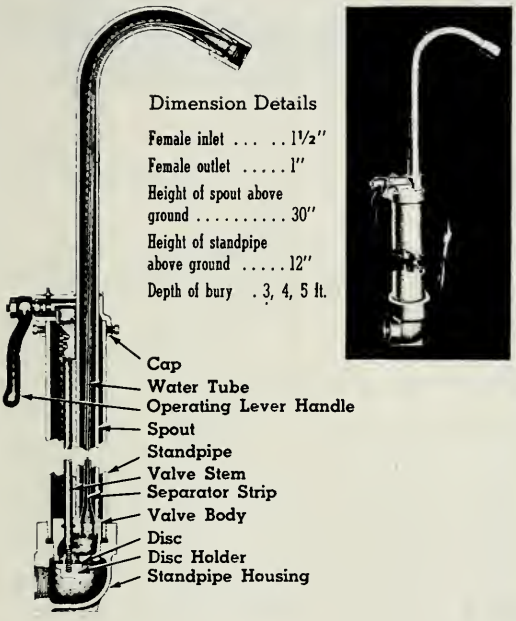

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Seppa, K. E., Sls. Engr., Armco Steel Corp., Metal Prod. Div., 220 W. Harrison, Seattle, Wash. 1960
Shipley, M. S., Pres., The Esbec Corp., P. O. Box 929, Stamford, Conn. 1960
Smith, C. E., Dist. Sls. Mgr., American Brake Shoe Co., P. O. Box 7353, Houston 8, Tex. . 1960
Standish, J. H., Sls. Rep., American Brake Shoe, R. R. Prod. Div., P. O. Box 7353, Houston, Texas 1961
Storer, J. W., Vice Pres.. Osmose Wood Preserving Co., 4505 Monona Drive, Madison, Wis. 1961

T

Tesnow, E. H., Gen. Fore., Pettibone Mulliken Corp., 4710 W. Division St., Chicago, Ill. 1960
Thomas, J. M., Mgr. R. R. Sls., Armco Steel Corp., Metal Prod. Div., P. O. Box 4688, Portland 2, Ore. 1960
Treece, J. H., Mgr. R. R. Sls., Binks Mfg. Co., 3114 W. Carroll Ave., Chicago, Illinois . . 1962

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Warrenfells, J. F., So. Sls. Mgr., Weir Kilby Corp., Taylor-Wharton Co., Birmingham, Ala. 1946
Weiss, W. E., Sls. Engr., Pettibone Mulliken Corp., 4710 W. Division St., Chicago 51, Ill. 1956
White, H. L., Ch. Sls. Engr., Armco Steel Corp., Metal Prod Div., 1001 Grove St., Middletown, Ohio 1962
Williams, C. B., Pres., Ever Tight Bolt Assembly Co., 238 Lincoln Ave., Council Bluffs, Ia. 1954
Williams, G. S., Supt., Southern Amiesite Asphalt Co., Inc., 3401 5th Ave. No., Birmingham, Ala. 1956
Williamson, W. M., Res. Rep., Fairmont Railway Motors, Inc., 2208 Riverside Drive, Houston 4, Tex. 1960
Wilson, W. C., Pres., Southeastern Ry. Supply, Inc., P. O. Box 368, Arlington 10, Va. . . 1951
Wingerson, C., Ry Sls. Engr., Screw & Bolt Corp. of America, P. O. Box 1708, Pittsburgh 30, Pa. 1954

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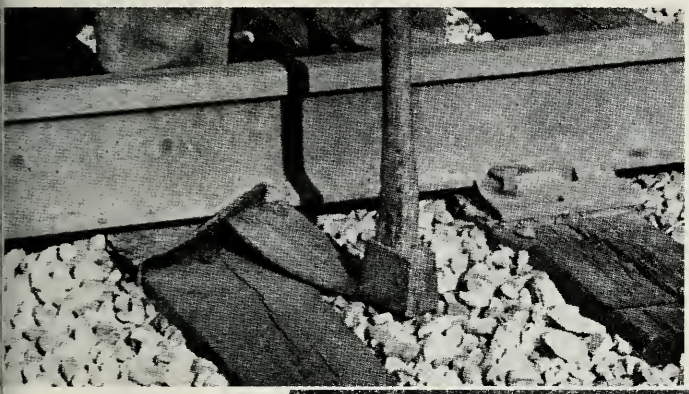

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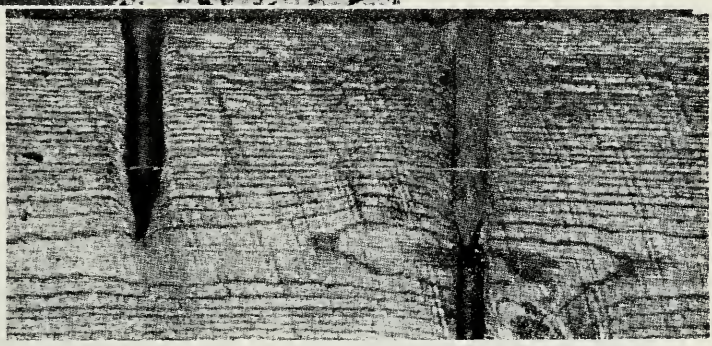
retouched photograph of cross tion of tie shows underplate ea, including spike holes, after years' protection by Bird Self- aling Tie Pad. There is no ce of the destructive effects of isture and abrasion in these nerable areas. Moisture and rasive materials could not netrate the seal.



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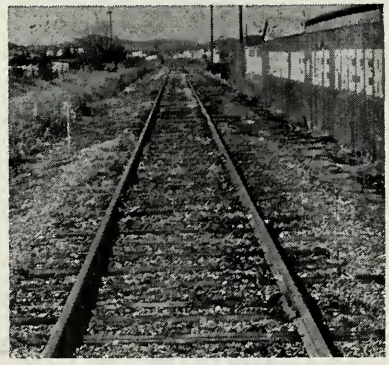

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Track Specialties Co., Inc.
Transportation Products Company
True Temper Corp.

Union Switch & Signal Div. Westinghouse Air Brake Co.
United Tractor, Inc.
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U. S. Borax & Chemical Corp.

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